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SURFACE TENSION IN RELATION TO CELLULAR PROCESSES[1]

THE record of investigation of the phenomena of the life of animal and vegetable cells for the last eighty years constitutes a body of knowledge which is of imposing magnitude and of surpassing interest to all who are concerned in the studies that bear on the organic world. The results won during that period will always constitute, as they do now, a worthy memorial of the intense enthusiasm of the scientific spirit which has been a distinguishing feature of the last six decades of the nineteenth century. We are to-day, in consequence of that activity, at a point of view the attainment of which could not have been predicted half a century ago.

This body of knowledge, this lore which we call cytology, is still with all this achievement in one respect an undeveloped science. It is chiefly—nay, almost wholly—concerned with the structural or morphological side of the cell, while of the functional phenomena our knowledge is only of the most general kind, and the reason is not far to seek. What little we know of the physiological side of the cell —as, for example, of cellular secretion, absorption and nutrition—has only to a very limited extent been the outcome of observations directed to that end. It is in very great part the result of all the inferences and generalizations drawn from the data of morphological research. This knowledge is not the less valuable or the less certain because it has been so won, but simply

[1] Address to the Physiological Section of the British Association for the Advancement of Science, Sheffield, 1910.

because of its source and of the method by which we have gained it, it is of a fragmentary character, and therefore less satisfactory in our estimation.

This state of our knowledge has affected —or, to express it more explicitly, has fashioned—our concept of living matter. When we think of the cell it is idealized as a morphological element only. The functional aspect is not ignored, but we know very little about it, and we veil our ignorance by classing its manifestations as vital phenomena.

It is true that in the last twenty years, and more particularly in the last ten, we have gathered something from biochemical research. We know much concerning ferment or catalytic action, of the physical characters of colloids, of the constitution of proteins, and their synthesis in the laboratory promises to be an achievement of the near future. We are also in a position to understand a little more clearly what happens in proteins when, on decomposition in the cell, they yield the waste products, urea, and other metabolites, with carbon dioxide and water. Further, fats can be formed in the laboratory from glycerine and fatty acids, a large number of which have also been synthesized, and a very large majority of the sugars of the aldohexose type have been built up from simpler compounds. These facts indicate that some of the results of the activity of animal and vegetable cells may be paralleled in the laboratory, but that is as far as the resemblance extends. The methods of the laboratory are not as yet those of nature. In the formation of carbohydrates, for example, the chlorophyll-holding cell makes use of processes of the most speedy and effective character, but nothing of these is known to us except that they are quite unlike the processes the laboratory employs in the artificial synthesis of carbohydrates. Nature works unerringly, unfalteringly, with an amazing economy of material and energy, while "our laboratory syntheses are but roundabout ways to the waste sink."

In consequence, it is customary to regard living matter as unique—*sui generis*, as it were, without an analogue or parallel in the inorganic world—and the secrets involved in its actions and activities as insoluble enigmas. Impelled by this view there are those, also, who postulate as an explanation for all these manifestations the intervention in so-called living matter of a force otherwise and elsewhere unknown, biotic or vital, whose action is directed, according to the character of the structure through which it operates, to the production of the phenomena in question. Living protoplasm is, in this view, but a mask and a medium for action of the unknown force.

This is an old doctrine, but it has again made headway in recent years owing to the reaction from the enthusiasm which came from the belief that the application of the known laws of physics and chemistry in the study of living matter would explain all its mysteries. A quarter of a century ago hopes were high that the solution of these problems would soon be found in a more profound comprehension of the laws of the physical world. Since then there has been an extraordinary increase in our knowledge of the structure and of the products of the activity of living matter without a corresponding increase in knowledge of the processes involved. The obscurity still involving the latter appears all the greater because of the high lights thrown on the former. Despair, in consequence, has taken the place of hope with some, and the action of a mysterious force is invoked to explain a mystery.

It may be admitted that our methods of

investigation are very inadequate, and that our knowledge of the laws of matter, seemingly comprehensive, is not at present profound enough to enable us to solve all the problems involved in the vital phenomena. The greatest factor in the difficulty of their solution, however, has been the fact that there has been a great lack of investigators specially trained not only in biology, but also in physics and chemistry, for the very purpose of attacking intelligently such problems. The biologists, for want of such a wide training, have emphasized the morphological aspect and the readily observable phenomena of living matter; while the physicist and chemist, knowing little of the morphology of the cell and of its vital manifestations, have been unable to apply satisfactorily the principles of their sciences to an understanding of its processes. The high degree of specialism which certain departments of biology has in recent years developed has made that difficulty greater than it was.

It must also be said that in some instances in which the physicist and chemist attempted to aid in the solution of biological problems the result on the whole has not been quite satisfactory. In, for example, the phenomena of osmosis, the application of Arrhenius's theory of ionization and van't Hoff's gas theory of solutions promised at first to explain all the processes and the results of diffusion through animal membranes. These theories were supported by such an array of facts from the side of physics and physical chemistry that there appeared to be no question whatever regarding their universal validity, and their application in the study of biological phenomena was urged with acclaim by physical chemists and eagerly welcomed by physiologists. The result in all cases was not what was expected. Diffusion of solutes, according to the theories, should, if the membrane is permeable to them, always be from the fluid where their concentration is high to that in which it is low. This appears to happen in a number of instances in the case of living membranes—or, at least, we may assume that it occurs—but in one signal instance at least the very reverse normally obtains. In the kidney, membranes formed of cells constituting the lining of the glomeruli and the renal tubules separate the urine, as it is being formed, from the blood plasma and the lymph circulating through the kidney. Though the excreted fluid is derived from the plasma and lymph, it is usually of much greater osmotic concentration than the latter.

It may be urged that this and other discrepancies are explained by the distribution (or partition) coefficient of the solutes responsible for the greater concentration of the product of excretion, these solutes being more soluble in the excreted medium than in the blood plasma and distributing or diffusing themselves accordingly. If such a principle is applicable here as an explanation, it may be quite as much so in other physiological cases in which the results are supposedly due only to the forces postulated in the theories of van't Hoff and Arrhenius. Whether this be so or not, the central fact remains that the enthusiastic hopes with which the theories were applied by physiologists and biologists in the explanation of certain vital phenomena have not been wholly realized.

The result has been a reaction amongst physiologists and biologists which has not been the least contributory of all the causes that have led to the present revival of vitalism.

Another difficulty in accounting for the vital phenomena has been due, until recently, to a lack of knowledge of the physical and chemical properties of colloids

and colloidal "solutions." The importance of this knowledge consists in the fact that protoplasm, "the physical basis" of life, consists mainly of colloids and water. Till eleven years ago what was known regarding colloids was derived chiefly from the researches of Graham (1851–62), Ljubavin (1889), Barus and Schneider (1891), and Linder and Picton (1892–97), who were the pioneers in this line. In 1899 were published the observations of Hardy, through whose investigations very great progress in our knowledge of colloids was made. In 1903 came the invention of the ultramicroscope by Siedentopf and Zsigmondy, by which the suspension character of colloid material in its so-called "solutions" was visually demonstrated. During the last seven years a host of workers have by their investigations greatly extended our knowledge of the physical and chemical properties of colloids, and now the science of collochemistry bids fair, the more it develops, to play a very important part in all studies bearing on the constitution and properties of living matter.

Then, also, there are the phenomena of surface tension. This force, the nature of which was first indicated by Segner in 1751, and described with more detail by Young in 1804 and La Place in 1806 in the expositions of their theories of capillarity, was first in 1869 only casually suggested as a factor in vital processes by Engelmann. Since the latter date and until 1892, when Bütschli published his observations on protoplasmic movements, no serious effort was made to utilize the principle of this force in the explanation of vital phenomena. Even to-day, when we know more of the laws of surface tension, it is only introduced as an incidental factor in speculations regarding the origin of protoplasmic movement and muscular contraction, and yet it is, as I shall maintain later on in this address, the most powerful, the most important of all the forces concerned in the life of animal and vegetable cells.

It may be gathered from all that I have advanced here that the chief defect in biological research has been, and is, the failure to apply thoroughly the laws of the physical world in the explanation of vital phenomena. Because of this too much emphasis is placed on the division that is made between the biological and the physical sciences. This division is very largely an artificial one, and it will in all probability be maintained eventually only as a convenience in the classification of the sciences. The biologist and physiologist have to deal with problems in which a wide range of knowledge is necessary for their adequate treatment; and, if the individual investigator has not a very extensive training in the physical sciences, it is impossible for him to have at his command all the facts bearing on the subject of his research, unless the problem involved be a very narrow one. The lack of this wide knowledge of the physical sciences tends to specialism, and, as the specialism is ever growing, it will produce a serious situation eventually, for it will develop a condition in the scientific world in which coordination of effort and a broad outlook will be much more difficult than is the case now.

This growing defect in the biological sciences can only be lessened by the insistence of those in charge of advanced courses in biological and physiological laboratories that only they whose training is of a very wide character should be allowed to take up research. It is, perhaps, futile to expect that such a rule will ever be enforced, for in the keen competition between universities for young teachers who have made some reputation for original investigation there may not be too close a scrutiny

of the qualifications of those who offer themselves for post-graduate courses. There is, further, the difficulty that the heads of scientific departments are not desirous of limiting the output of new knowledge from their laboratories by insisting on the wider training for the men of science who are in the process of developing as students of research.

It is perhaps true, also, that there still remains a great deal unobserved or unrecorded in the fields of biology, physiology and biochemistry, in the investigation of all of which a broad training is not specially required to give good service; and that, further, this condition will obtain for one or two decades still. It is quite as certain, however, that the returns from such service will tend to diminish in number and value, and, if the coming generation of workers is not recruited from a systematically and broadly trained class of students, a period of comparative sterility may supervene.

As it is to-day, there are few who devote themselves to the direct study of the chemical and physical properties of the cell, the fundamental unit of living matter. There are, of course, many who are concerned with the morphology of the cell, and who employ in their studies the methods of hardening and staining which have been of very great service in revealing the structural as well as the superficial chemical properties of the cell. On the facts so gained views are based which deal with the chemistry of the cell, and which are more or less widely accepted, but the results and generalizations drawn from them give us but little insight into the chemical constitution of the cell. We recognize in the morphologists' chromatin a substance which has only in a most general way an individuality, while the inclusions in the nucleus and the cytoplasm, on whose distinction by staining great emphasis is laid, can only in a most superficial way be classified chemically.

The results of digestion experiments on the cell structures are also open to objection. The action of pepsin and hydrochloric acid must depend very largely on the accessibility of the material whose character is to be determined. If there are membranes protecting cellular elements, pepsin, which is a colloid, if it diffuses at all, must in some cases at least penetrate them with difficulty. In *Spirogyra*, for example, the external membrane formed of a thick layer of cellulose is impermeable to pepsin, but not to the acid; and, in consequence, the changes which occur in it during peptic digestion are due to the acid alone. Even in the cell whose periphery is not protected by a membrane, the insoluble colloid material at the surface serves as a barrier to the free entrance of the pepsin. It is, however, more particularly in the action on the nucleus and its contents that peptic digestion fails to give results which can be regarded as free from objection. Here is a membrane which during life serves to keep out of the nucleus not only all inorganic salts but also all organic compounds, except chiefly those of the class of nucleo-proteins. That such a membrane may, when the organism is dead, be permeable to pepsin is at least open to question, and in consequence what we see in the nucleus after the cell has been acted on by pepsin and hydrochloric acid can not be adduced as evidence of its chemical or even of its morphological character.

The results of digestive experiments on cells are, therefore, misleading. What may from them appear as nucleo-protein may be anything but that, while, if the pepsin penetrates as readily as the acid, there should be left not nucleo-protein, but pure nucleic acid, which should not stain at all.

The objections which I now urge against the conclusions drawn from the results of digestion experiments have developed out of my own observations on yeast cells, diatoms, *Spirogyra,* and especially the blue-green algæ. The latter are, as is *Spirogyra,* encased in a membrane which is an effective barrier to all colloids. When, therefore, threads of *Oscillaria* are subjected to the action of artificial gastric juice, a certain diminution in volume is observed owing to the dissolving power of the hydrochloric acid, and an alteration of the staining power of certain structures is found to obtain, but the pepsin has nothing to do with these, as may be determined by examination of control preparations treated with a solution of hydrochloric acid alone.

It is thus seen how slender is our knowledge of the chemistry of cells derived from staining methods and from digestion experiments. That, however, has not been the worst result of our confidence in our methods. It has led cytologists to rely on these methods alone, to leave undeveloped others which might have thrown great light on the chemical constitution of the cell, and which might have enabled us to understand a little more clearly the causation of some of the vital phenomena.

It was the futility of some of the old methods that led me, twenty years ago, to attack the chemistry of the cell from what appeared to me a correctly chemical standpoint. It seemed to me then, and it appears as true now, that a diligent search for decisive chemical reactions would yield results of the very greatest importance. In the interval I have been able to accomplish only a small fraction of what I hoped to do, but I think the results have justified the view that, if there had been many investigators in this line instead of only a few, the science of cytochemistry would play a larger part in the solution of the problems of cell physiology than it now does.

The methods and the results are, as I have said, meager, but they show distinctly indeed that the inorganic salts are not diffused uniformly throughout the cell; that in vegetable cells they are rigidly localized, while in animal cells, except those devoted to absorption and excretion, they are confined to specified areas in the cell. Their localization, except in the case of inorganic salts of iron, is not due to the formation of precipitates, but rather to a condition which is the result of the action of surface tension. This seems to me to be the only explanation for the remarkable distribution, for example, of potash salts in vegetable cells. We know that, except in the chloroplatinate of potassium and in the hexanitrite of potassium, sodium and cobalt, potassium salts form no precipitates; and yet, in the cytoplasm of vegetable cells, the potassium is so localized at a few points as to appear at first as if it were in the form of a precipitate. In normal active cells of *Spirogyra* it is massed along the edge of the chromotophor, while in the mesophyllic cells of leaves it is condensed in masses of the cytoplasm, which are by no means conspicuous in ordinary preparations of these cells.

This effect of surface tension in localizing the distribution of inorganic salts at points in the cytoplasm would explain the distribution of potassium in motor structures. In striated muscle the element is abundant in amount, and is confined to the dim bands in the normal conditions. In *Vorticella,* apart from a minute quantity present at a point in the cytoplasm, it is found in very noticeable amounts in the contractile stalk; while in the holotrichate infusoria (*Paramœcium*) it is in very intimate association with the basal elements of the cilia in the ectosarc. This, indeed, would seem to indi-

cate that the distribution of the potassium is closely associated with contraction, and, therefore, with the production of energy in contractile tissues. The condensation of potassium at a point may, of course, be a result of a combination with portions of the cytoplasm, but we have no knowledge of the occurrence of such compounds; and, further, the presence of such does not explain anything, or account for the liberation of energy in motor contraction. On the other hand, the action of surface tension would explain not only the localization of the potassium but also the liberation of the energy.

In vessels holding fluids the latter, in relation to surface tension, have two surfaces —one free, in contact with the air, and known as the air-water surface; the other, that in contact with the wall of the containing vessel (glass). In the latter the tension is lower than in the former. When an inorganic compound—a salt, for example—is dissolved in the fluid it increases the tension at the air-water surface, but its dilution is much greater here than in any other part of the fluid; while at the other surface its concentration is greatest. In the latter case the condition is of the nature of adsorption. The condensation on that portion of the surface where the tension is least is responsible for what we find when a solution of a colored salt, as, *e. g.*, potassium permanganate, is driven through a layer of dry sand. If the latter is of some considerable thickness the fluid as it passes out is colorless. The air-solution surface tension is higher than the tension of each of the solution-sand surfaces on which, therefore, the permanganate condenses or is adsorbed. The same phenomenon is observed when a long strip of filter paper is allowed to hang with its lower end in contact with a moderately dilute solution of a copper salt. The solution is imbibed by the filter paper, and it ascends a certain distance in a couple of minutes, when it may be found that the uppermost portion of the moist area is free from even a trace of copper salt.

If, on the other hand, an organic compound—as, for instance, one of the bile salts—instead of an organic compound is dissolved in the fluid, the surface tension of the air-water surface is reduced, and in consequence the bile salt is concentrated at that surface; while in the remainder of the fluid, and particularly in that portion of it in contact with the wall of the vessel, the concentration is reduced.

The distribution of a salt in such a fluid, whether it lowers surface tension or increases it, is due to the action of a law which may be expressed in words to the effect that the concentration in a system is so adjusted as to reduce the energy at any point to a minimum.

Our knowledge of this action of inorganic and organic substances on the surface tension in a fluid and of the differences in their concentrations throughout the latter was contained in the results of the observations on gas mixtures by J. Willard Gibbs, published in 1878. The principle as applied to solutions was independently discovered by J. J. Thomson in 1887. It is known as the Gibbs's principle, although the current enunciations of it contain the more extended observations of Thomson. As formulated usually it is more briefly given, and its essential points may be rendered in the statement *that when a substance on solution in a fluid lowers the surface tension of the latter the concentration of the solute is greater in the surface layer than elsewhere in the solution; but when the substance dissolved raises the surface tension of the fluid, the concentration of the solute is least in the surface layers of the solution.*

It is thus seen how in a system like that of a drop of water with different contact surfaces the surface tension is affected and how this alters the distribution of solutes. It is further to be noted that for most organic solutes the action in this respect is the very reverse of that of inorganic salts. Consequently, in a living cell which contains both inorganic and organic solutes, and in which there are portions of different composition and density, the equilibrium may be subject to disturbance constantly through an alteration of the surface tension at any point. Such a disturbance may be found in a drop of an emulsion of olive oil and potassium carbonate in the well-known experiments of Bütschli. When the emulsion is appropriately prepared, a minute drop of it, after it is surrounded with water, will creep under the cover glass in an amœboid fashion for hours, and the movement will be more marked and rapid when the temperature is raised to 40 to 50° C. All the phenomena manifested are due to a lowering of the surface tension at a point on the surface, as a result of which there is protrusion there of the contents of the drop, accompanied, Bütschli holds, by steaming cyclic currents in the remainder of the mass.

Surface tension also, according to J. Traube, is all-important in osmosis, and he holds that it is the solution pressure (*Haftdruck*) of a substance which determines the velocity of the osmotic movement and the direction and force of the osmotic pressure. The solution pressure of a substance is measured by the effect that substance exercises when dissolved on the surface tension of its solution, or, to put it in Traube's own way, the more a substance lowers or raises the surface tension of a solvent (water) the less or greater is the solution pressure (*Haftdruck*) of that substance. This solution pressure, Traube further holds, is the only force controlling osmosis through a membrane, and he rejects completely the bombardment effect on the septum postulated in the van't Hoff theory of osmosis.

The question as to the nature of the factors concerned in osmosis must remain undecided until the facts have been more fully studied from the physiological standpoint, but enough is now known to indicate that surface tension plays at least a part in it, and the omission of all consideration of it as a factor is not by any means a negligible defect in the van't Hoff theory of osmosis.

The occurrence of variations in surface tension in the individual cells of an organ or tissue is difficult to demonstrate directly. We have no methods for that purpose, and, in consequence, one must depend on indirect ways to reveal whether such variations exist. The most effective of these is to determine the distribution of organic solutes and of inorganic salts in the cell. The demonstration of the former is at present difficult or even in some cases impossible. The occurrence of soaps which are amongst the most effective agents in lowering surface tension may be revealed without difficulty microchemically, as may also neutral fats, but we have as yet no delicate microchemical tests for sugars, urea, and other nitrogeneous metabolites, and in consequence the part they play, if any, in altering the surface tension in different kinds of cells, is unknown. Further research may, however, result in discovering methods of revealing their occurrence microchemically in the cell. We are in a like difficulty with regard to sodium, whose distribution we can determine microchemically in its chief compounds, the chloride and phosphate, only after the exclusion of potassium, calcium and magnesium. We

have, on the other hand, very sensitive reactions for potassium, iron, calcium, haloid chlorine and phosphoric acid, and with methods based on these reactions it is possible to localize the majority of the inorganic elements which occur in the living cell.

By the use of these methods we can indirectly determine the occurrence of differences in surface tension in a cell. This determination is based on the deduction from the Gibbs-Thomson principle that, where in a cell an inorganic element or compound is concentrated, the surface tension at the point is lower than it is elsewhere in the cell. If, for example, it is concentrated on one wall of a cell the surface tension there is less than on the remaining surfaces or walls of the cell. The thickness of this layer must vary with the osmotic concentration in the cell, with the specific composition of the colloid material of the cytoplasm and with the activity of the cell, but it should not exceed a few hundredths of a millimeter (0.02–0.04 mm.), while it might be very much less in an animal cell whose greatest diameter does not exceed 20 μ.

Numerous examples of such localization may be observed in the confervoid protophyta. In *Ulothrix,* ordinarily, there is usually a remarkable condensation of the potassium at the ends of the cell on each transverse wall. The surface tension, on the basis of the deduction from the Gibbs-Thomson principle, should be, in all these cases, high on the lateral walls and low on those surfaces adjoining the transverse septa.

The use of this deduction may be extended. There are in cells various inclusions whose composition gives them a different surface tension from that prevailing in the external limiting area of the cell. Further, the limiting portion of the cytoplasm in contact with these inclusions must have surface tension also. When, therefore, we find by microchemical means that a condensation of an inorganic element or compound obtains immediately within or without an inclusion, we may conclude that there, as compared with the external surface of the cell, the surface tension is low. It may be urged that the condensation is due to adsorption only, but this objection can not hold, for in the Gibbs-Thomson phenomena the localization of the solute at a part of the surface as the result of high tension elsewhere of the solution is, in all probability, due to adsorption, and is indeed so regarded.[2]

It is in this way that we can explain the remarkable localization of potassium in the cytoplasm at the margins of the chromatophor in *Spirogyra* and also the extraordinary quantities of potassium held in or on the inclusions in the mesophyllic cells of leaves. In infusoria (*Vorticella, Paramœcium*) the potassium present apart from that in the stalk or ectosarc is confined to one or more small granules or masses in the cytoplasm.

How important a factor this is in clearing the active portion of the cytoplasm of compounds which might hamper its action, a little consideration will show. In plants very large quantities of salts are carried to leaves by the sap from the roots, and among these salts those of potassium are the most abundant as a rule. Reaching the leaves these salts do not return, and in consequence during the functional life of the leaves they accumulate in the mesophyllic cells in very large quantities, which, if they were not localized as described in the cell, would affect the whole cytoplasm and alter its action.

Enough has been advanced here to indicate that surface tension is not a minor feature in cell life. I would go even

[2] See Freundlich, "Kapillarchemie," p. 50, 1909.

farther than this and venture to say that the energy evolved in muscular contraction, that also involved in secretion and excretion, the force concerned in the phenomena of nuclear and cell division, and that force also engaged by the nerve cell in the production of a nerve impulse are but manifestations of surface tension. On this view the living cell is but a machine, an engine, for transforming potential into kinetic and other forms of energy, through or by changes in its surface energy.

To present an ample defence of all the parts of the thesis just advanced is more than I propose to do in this address. That would take more time than is customarily allowed on such an occasion, and I have, in consequence, decided to confine my observations to outlines of the points as specified.

It is not a new view that surface tension is the source of the muscular contraction. As already stated, the first to apply the explanation of this force as a factor in cellular movement was Engelmann in 1869, who advanced the view that those changes in shape in cells which are classed as contractile are all due to that force which is concerned in the rounding of a drop of fluid. The same view was expressed by Rindfleisch in 1880, and by Berthold in 1886, who explained the protoplasmic streaming in cells as arising in local changes of surface tension between the fluid plasma and the cell sap, but he held that the movement and streaming of *Amœbæ* and *Plasmodiæ* are not to be referred to the same causes as operate in the protoplasmic streaming in plant cells. Quincke in 1888 applied the principle of surface tension in explaining all protoplasmic movement. In his view the force operates, as in the distribution of a drop of oil on water, in spreading protoplasm, which contains oils and soaps, over surfaces in which the tension is greater, and as soap is constantly being formed, the layer containing it, having a low tension on the surface in contact with water, will as constantly keep moving, and as a result pull the protoplasm with it. The movement of the latter thus generated will be continuous and constitute protoplasmic streaming. In a similar way Bütschli explains the movement of a drop of soap emulsion, the layer of soap at a point on the surface of the spherule dissolving in the water and causing there a low tension and a streaming of the water from that point over the surface of the drop. This produces a corresponding movement in the drop at its periphery and a return central or axial stream directed to the point on the surface where the solution of the soap occurred and where now a protrusion of the mass takes place resembling a pseudopodium. In this manner, Bütschli holds, the contractile movements of *Amœbæ* are brought about. In these the chylema or fluid of the foam-like structure in the protoplasm is alkaline, it contains fatty acids and, in consequence, soaps are present which, through rupture of the superficial vesicles of the foam-like structure at a point, are discharged on the free surface and produce there the diminution of surface tension that calls forth currents, internal and external, like those which occur in the case of the drop of oil emulsion.

A. B. Macallum

(To be continued)

METEOROLOGY AT THE SHEFFIELD MEETING OF THE BRITISH ASSOCIATION

The work on meteorology for the British Association for the Advancement of Science is organized under Section A—Mathematical and Physical Science—and under the subsection (*b*) Cosmical Physics and Astronomy. There can be no more pronounced recognition of the opinion that meteorology has already made good its claim to be considered as a subordinate branch of solar and cosmical physics,

due to the fact that the temporary physical state of the earth's atmosphere is what it is at any point in consequence of the effects of solar radiation in the earth's circulating atmosphere. This subject has developed so many difficult problems in the relations of temperature distribution to local absorption and emission of radiant energy, of radiation to ionization, atmospheric electricity and magnetism and of heat energy to general and local circulation, that the best resources of astronomers, physicists and mathematicians are called upon for their solution. The extent and range of these complex subjects, and the number of able scientists who are interested in them, is making a demand that meteorology shall be recognized as an independent section of the British Association for the Advancement of Science. This question is receiving the careful consideration of the council, and the several conflicting claims will be weighed, with the present probability that the new section will be established.

The meeting of September 6 was opened by a discussion of the status of the problems of atmospheric electricity, being a résumé of the practical aspect of the theory and the apparatus, by Dr. Charles Chree, superintendent of the Kew Magnetic Observatory. The Thomson water-dropping apparatus for the electrical potential has been recently so far improved that the average gradient in volts per meter has risen from 200 to 300 in many cases. The Elster and Geitel apparatus for dissipation of electric charges, and the conductivity of the air, is still vitiated by the difficulty of saturated fields around the charged body. The Ebert ion-counter does not clear the passing current of air of all the contained ions. In short, the work of arriving at any absolute standard instruments is still very considerable. Sir Oliver Lodge followed with an account of Lemström's application of static electricity to the growth of plants, as indicated by experiments in England, and fully recommended further investigations. Professor J. J. Thomson discussed the very high tension electricity in the atmosphere as exhibited in thunder storms, and preferred to refer it to the action of convection currents. Dr. W. N. Shaw gave an interesting account of several meteorological problems along these lines. The consensus of opinion is clear that this entire range of problems requires much more work of investigation in every possible way before any conclusion of a definitive sort will be possible.

The individual papers were as follows:

Dr. W. Schmidt, of Vienna, described an apparatus for measuring the short waves of the barometric pressure, as where a warm current overflows a cold current, after the analogy of Helmholtz's long waves, and fully illustrated the subject by an application to the local conditions at Innsbruck.

Mr. W. H. Dines exhibited his instrument for the simultaneous self-recording of the pressure and temperature of the air at all elevations reached by balloons. It is very light, weighing only a few ounces, and makes the record without magnification on a small plate, to be read under a microscope at leisure. He showed his records and pointed out that observations made in sunshine are so much affected by radiation that soundings should be carried on at night, in order to avoid the loop in the ascending and descending branches.

Dr. J. W. Nicholson developed a method of studying the effects of radiation pressure on small particles of different sizes, together with the necessary criteria for application to the forms of comets' tails.

Miss M. White, of Manchester, gave the results of a remarkable set of ascensions made in March, 1910. It seems that twenty-eight balloons were sent up in a single 24-hour interval, and the combined records were exhibited. These small balloons, costing about five dollars each, equipped with Dine's instruments, penetrated to about 20,000 meters, and they showed the lower level of the isothermal layer to have been at about 11,000 meters in height. Such perfectly definite measures of temperature are of course very valuable because from them the pressure, density and gas coefficient can be computed, and many important conclusions depend upon these facts. No expensive observatory establishment is necessary for such work, and similar observations ought to be made in all parts of the world.

Mr. R. F. Stupart, director of the Canadian Service, showed that temperature inversion effects occur in Alberta, similar to those previously found by Bigelow over the Rocky Mountain region in the northwestern states, showing that the warming adiabatic currents flow as a sheet eastward over the mountains for many hundred miles in a north-and-south line, from northern Alberta to Colorado.

Mr. E. Gold gave a paper with summary regarding the effects of radiation on the height and temperature of the isothermal layer over cyclones, anticyclones, in the tropics and the temperate zones generally. The interrelations of this complex problem were briefly considered, the result being that many more observations are needed, especially in the tropics.

Professor F. G. Baily exhibited diagrams and models of a sensitive seismograph, being an extension of a vertical bifilar system, the mirror being suspended from a bifilar hanging on a bifilar. The records are promising and the instrument is not heavy or bulky.

All the papers were of an excellent quality, and the discussions, though limited for lack of time, were intelligent, showing that these subjects are of primary interest in England.

There are other matters of importance just now occurring, under the able administration of Dr. W. N. Shaw, in the British Meteorological Service. The old office in Victoria Street, London, is being removed to South Kensington, for the sake of enlarged quarters, and the personnel of the service is being strengthened. The Kew Magnetic Observatory, Dr. C. Chree, director, long an independent and well-known institution for magnetic work, has been amalgamated with the Meteorological Office, and they now form one service. This office is also in close touch with the South Kensington Solar Physical Observatory, Sir Norman Lockyer, director, so that the allied branches of solar physics, atmospheric electricity and magnetism, meteorological records and forecasting, are acting in close harmony. This would be like uniting the astrophysical observatory of the Smithsonian Institution, the magnetic department of the Carnegie Institution so far as it relates to atmospheric phenomena, and the Weather Bureau, a policy which I think should be advocated until it has been accomplished. There is great scientific disadvantage in carrying on these lines of research independently, and it should be remedied before large masses of valuable observations accumulate. Mr. Stupart informs me that the Canadian government is establishing, in connection with the magnetic observatory at Agincourt, about ten miles from Toronto, a fully equipped institution for balloon and kite work, for atmospheric electricity in all its relations to ionization, and for solar radiation. The balloon work will be valuable in supplementing the Mt. Weather work on cyclones and anticyclones, because the location of the southern station is such that the great majority of the storms run to the northward of it, so that the data are over-abundant in the southern and scanty in the northern quadrants, and make a difficult distribution of material for any important discussions. I am also informed that the Argentine government is making large extensions of their service along similar lines of general physics. Since it is necessary that meteorology should be carried on by governments with considerable resources, on account of the necessity in forecasting of an elaborate organization for collecting data promptly, it follows that they at the same time assume the responsibility for the maintenance of researches tending to improve the service for the public utility.

Meteorology is a difficult subject, and it requires unusual effort and expenditure of money to make any important progress. It is evident, however, that scientists in all parts of the world are in agreement with the policies pursued by the three governments just mentioned as the most practical way of attacking the great problems in question.

Frank H. Bigelow

Sheffield, Eng.,
September 7, 1910

THE TENTH ANNUAL NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL EXCURSION

The party will assemble late Friday afternoon, October 21, at the Hanover Inn, Hanover, N. H. After supper there will be a preparatory meeting, at which short expositions

will be given of certain phases of the geology of northern New England, and questions will be raised upon which the subsequent field trip should throw light. Opportunity will be given to inspect Hitchcock's large geological model of New Hampshire and Vermont (scale 1 inch to one mile), the various rock collections made during the progress of the State Surveys of 1861–79, Dr. Hawes's original set of "thin" sections of New Hampshire rocks, Warren Upham's original maps of the surface deposits of the Connecticut and Merrimac valleys, and other exhibits at the Dartmouth College Museum which illustrate pioneer work on the geology of northern New England.

On Saturday morning short excursions will be made to several points in the valley near Hanover, and in the afternoon to the vicinity of White River Junction. Some of the features to be seen and questions to be discussed are: The Connecticut valley esker; its relation to other deposits in the valley? Clays, which compose the "highest terrace"; their original extent? of glacio-fluvial or glacio-lacustrine origin? Deltas at mouths of tributary valleys, at altitudes above the "highest terrace"; their significance? Ice-contact slopes and kettle-holes, how discriminated from subsequent stream-carved topography? Erosion slopes of the Connecticut River, local trimming and local obliteration of the esker; intercision of a tributary stream by the master stream at a point some distance above their original junction; protective influence of ledges among the terraces? Unprotected terraces and abandoned courses (of incised meandering pattern) of tributary streams. Accordant altitudes of unprotected terraces up- and down-valley. Do some of these represent long pauses between stages of regional up-warping? Was the post-glacial elevation of New England steady and continuous, or interrupted by an interval of halting or subsidence?

The field excursion will close at White River Junction before the departure of the 5.35 P.M. train for Boston.

HERDMAN F. CLELAND,
Secretary

WILLIAMSTOWN, MASS.,
September 24, 1910

THE ILLUMINATING ENGINEERING SOCIETY

THE fourth annual convention of the Illuminating Engineering Society will be held October 24 and 25, 1910, in Baltimore, Maryland. The convention will meet at the Johns Hopkins University.

Following the two days convention there will be given at the university a course of thirty-six lectures on illuminating engineering. These lectures will be given in the physical laboratory from October 26 to November 8. A large number of those who will attend the convention have already arranged to take advantage of the opportunity offered by the lecture course. The lecturers have been invited by the university upon the advice of the society.

Plans are rapidly maturing for the convention proper. There will be two sessions on each day of the convention—morning and afternoon. On Monday evening there will be a public lecture in McCoy Hall to be followed at 9.30 by a reception in the physical laboratory and an exhibition of the apparatus to be used in the lecture course. On Tuesday evening there will be a banquet which will conclude the convention.

The lectures on illuminating engineering are as follows:

"The Physical Basis of the Production of Light" (three lectures), Joseph S. Ames, Ph.D., professor of physics, The Johns Hopkins University.

"The Physical Characteristics of Luminous Sources" (two lectures), Edward P. Hyde, Ph.D., president, Illuminating Engineering Society; director of Physical Laboratory, National Electric Lamp Association.

"The Chemistry of Luminous Sources" (one lecture), Willis R. Whitney, Ph.D., director of Research Laboratory, General Electric Co.; past president, American Chemical Society.

"Electric Illuminants" (two lectures), Charles P. Steinmetz, Ph.D., consulting engineer, General Electric Co.; professor of electrical engineering, Union University.

"Gas and Oil Illuminants" (two lectures), (1) M. C. Whitaker, B.S., M.S., professor of industrial chemistry, Columbia University. (2) Alexander C. Humphreys, M.E., Hon. Sc.D., presi-

dent of Stevens Institute of Technology; past president, American Gas Institute.

"The Generation and Distribution of Electricity with Special Reference to Lighting" (two lectures), John B. Whitehead, Ph.D., professor of applied electricity, The Johns Hopkins University.

"The Manufacture and Distribution of Gas, with Special Reference to Lighting" (two lectures), (1) Mr. E. G. Cowdery, vice-president of the People's Gas, Light and Coke Co., Chicago. (2) Mr. Walter R. Addicks, vice-president of Consolidated Gas Co., New York.

"Photometric Units and Standards" (one lecture), Edward B. Rosa, Ph.D., physicist, National Bureau of Standards.

"The Measurement of Light" (two lectures), Clayton H. Sharp, Ph.D., test officer, Electrical Testing Laboratory, New York City; past president, Illuminating Engineering Society.

"The Architectural Aspects of Illuminating Engineering" (two lectures), Walter Cook, A.M., vice-president, American Institute of Architects; past president, Society of Beaux Arts Architects.

"The Decorative Aspects of Illuminating Engineering" (one lecture), Mr. Louis C. Tiffany, president of the Tiffany Studios, New York.

"The Physiological Aspects of Illuminating Engineering" (two lectures), P. W. Cobb, B.S., M.D., physiologist of the Physical Laboratory of the National Electric Lamp Association.

"The Psychological Aspects of Illuminating Engineering" (one lecture), Dr. R. M. Yerkes, assistant professor of comparative psychology, Harvard University.

"The Principles and Design of Interior Illumination" (six lectures), (1) L. B. Marks, B.S., M.M.E., consulting engineer, New York City; past president, Illuminating Engineering Society. (2) Mr. Norman Macbeth, illuminating engineer, The Welsbach Co. (3) Professor W. E. Barrows, assistant professor of illuminating engineering, Armour Institute.

"The Principles and Design of Exterior Illumination" (three lectures), (1) Louis Bell, Ph.D., consulting engineer, Boston, Mass.; past president, Illuminating Engineering Society. (2) E. N. Wrightington, A.B., Boston Consolidated Gas Co.

"Shades, Reflectors and Diffusing Media" (one lecture), Van Rensselaer Lansingh, B.S., general manager of Holophane Co.

"Lighting Fixtures" (one lecture), Mr. Edward F. Caldwell, senior member of firm and designer, Edward F. Caldwell & Co., New York.

"The Commercial Aspects of Electric Lighting" (one lecture), John W. Lieb, Jr., M.E., third vice-president of New York Edison Co.; past president, American Institute of Electrical Engineers.

"The Commercial Aspects of Gas Lighting" (one lecture), Walton Clarke, M.E., president of The Franklin Institute, Philadelphia; third vice-president, United Gas Improvement Co., Philadelphia.

The laboratory demonstrations will be under the direction of: Charles O. Bond, manager of Photometric Laboratory, United Gas Improvement Company, Philadelphia; Herbert E. Ives, Ph.D., physicist, Physical Laboratory, National Electric Lamp Association, and Preston S. Millar, Electrical Testing Laboratories, New York, and general secretary, Illuminating Engineering Society.

SCIENTIFIC NOTES AND NEWS

The Academy of Sciences at Turin has elected as foreign members Professor Maximillian Noetcher, of Erlangen; Professor Adolf von Baeyer, of Munich; Professor Fr. Ed. Suess, of Vienna, and Professor J. J. Thomson, of Cambridge.

Dr. Hans Chiari, professor of pathological anatomy at Strasburg, is the lecturer this year on the Herter foundation of the Johns Hopkins University. He lectures on October 5 and 7.

Professor Arthur A. Noyes, director of the Research Laboratory of Physical Chemistry in the Massachusetts Institute of Technology, has been appointed non-resident university lecturer on chemical research in Clark University. Professor Arthur Michael will deliver before the university chemical students at Clark an informal lecture on some experiences in his organic researches.

The Warren triennial prize for 1910 of the Massachusetts General Hospital, Boston, has been awarded to Dr. George H. Whipple, assistant professor of pathology in Johns Hopkins University and resident pathologist in Johns Hopkins Hospital, for an essay on "The Pathogenesis of Icterus."

Dr. M. P. Ravenel, professor of bacteriology at the University of Wisconsin, is in Europe, where he will represent the University of Wisconsin at the centennial celebra-

tion of the University of Berlin, October 10–13.

DR. H. D. GEDDINGS, of the U. S. Public Health and Marine Hospital Service, represents the United States at the International Congress on Cancer, which opened at Paris, on October 1.

PROFESSOR C. K. LEITH, of the University of Wisconsin, sailed from New York on July 6, by way of England, for South America, where he was engaged in professional work for several months. Mr. E. C. Harder, of the U. S. Geological Survey, accompanied him as assistant.

DR. A. HRDLICKA, of the U. S. National Museum, has returned from a six months' expedition to Argentine and other parts of the South. The principal objects of the expedition, carried on under the auspices of the Smithsonian Institution, were a study of man's antiquity in Argentina, in which he was associated with Mr. Bailey Willis, of the U. S. Geological Survey, and of the coast people of Peru.

C. W. WRIGHT, who is managing mines in Sardinia, has been in Washington, completing a report on the Kasaan Peninsula, Alaska, for the U. S. Geological Survey.

DR. HEINRICH HASSELBRING, of the Bureau of Plant Industry, U. S. Department of Agriculture, will be in residence at the department of botany in the University of Chicago during the winter quarter (January–March) of the present academic year. He will give a course in plant pathology and will direct special work dealing with parasitic fungi. It is the purpose to establish in the department work in plant pathology on a physiological basis.

DR. HJÖRT will lecture before the Royal Geographical Society in January on the Michael Sars expedition for exploration in the Atlantic Ocean. Sir John Murray was associated with Dr. Hjört in the conduct of the expedition.

MR. R. T. A. INNES, director of the Transvaal Government Observatory, has just issued to its contributing observers a comparative table showing the average rainfall over the Transvaal for the six seasons 1904–05 to 1909–10, inclusive. This has been arrived at by dividing the Transvaal Province into a large number of areas, finding the average rainfall of each area, and taking the mean per unit area. In considering the result it should be borne in mind that the rainfall in different areas of the province varies from between 15 and 20 inches in the southwest, to between 70 and 80 or even more in the northeast. The six seasons' results and the average of six seasons are:

1909–10	28.8 inches	on 67 days.
1908–09	40.6 inches	on 83 days.
1907–08	22.3 inches	on 65 days.
1906–07	38.6 inches	on 84 days.
1905–06	23.2 inches	on 64 days.
1904–05	23.4 inches	on 76 days.
Average	29.5 inches	on 73 days.

THREE counties have been completed in detail by the state soil survey field parties now operating under the cooperative supervision of the soils department of the College of Agriculture of the University of Wisconsin, the State Geological and Natural History Survey and the U. S. Bureau of Soils. The completed counties are Waukesha, Iowa and Waushara. Only the field work is done, however, and a large amount of mapping and soil analysis remains to be completed so that reports will not be issued until a year or more later. Detailed surveys are in progress in three other counties, Fond du Lac, Juneau and La Crosse and the field parties will push the work as long this fall as the weather conditions will permit. Preliminary surveys are in progress in northern Ashland, Bayfield and Douglas counties. Such preliminary surveys were completed in the block of counties including Polk, Barron, Rusk, southern Price, Lincoln, St. Croix, Dunn, Chippewa, Taylor, Marathon, Pierce, Pepin, Eau Claire, Clark, Wood, Portage and the western part of Langlade as well as Marinette county. This first survey was mostly done by the geological and natural history survey, previous to the beginning of the state soil survey. The chemical analyses are being completed by the present survey. The U. S. Bureau of Soils is cooperating in the detail surveys but not in the preliminary

work. Previous to the beginning of the state survey the U. S. bureau had conducted surveys in the Viroqua area, the Janesville district, Racine county, the Portage district, and the Superior district. The field work and the soil analyses are under the direction of Professor A. R. Whitson, chief of the soils department of the College of Agriculture, Madison.

UNIVERSITY AND EDUCATIONAL NEWS

At Yale University the salaries of professors and assistant professors have been increased by $49,000 from the alumni fund. The salaries of full professors are to be $4,000 to $4,500 and $5,000, based mainly on length of service, but modified somewhat by university responsibility and personal distinction. In the case of assistant professors the maximum salary is increased to $3,000.

The newspapers have contained various inaccurate statements in regard to the Wyman bequest to the Graduate College of Princeton University, it having been at first exaggerated and recently underestimated. The amount of the bequest is, as originally stated in this Journal, between $2,000,000 and $3,000,000. All contests of the will have been withdrawn or overruled.

Dr. George Blumer has been elected dean of the medical school of Yale University, to succeed Dr. Herbert E. Smith.

The following members of the faculty at the University of Chicago have been promoted from associate professorships, heretofore held by them, to the rank of professor: Leonard Eugene Dickson (mathematics) and Robert Andrews Millikan (physics). The following have been promoted from assistant professors to be associate professors: W. W. Atwood (geology), H. H. Barrows (geography), J. Paul Goode (geography). A. C. Lunn (mathematics), has been promoted to an assistant professorship.

In the School of Mines of Pennsylvania State College the following appointments have been made: Mr. H. D. Pallister, M.E. (Case), formerly mining engineer with the Chisos Mining Co., Terlingua, Texas, and later instructor in mathematics, Case School, has been appointed instructor in metallurgy and Mr. Victor Ziegler, B.A. (Iowa), M.A. (Columbia), instructor in geology and mineralogy.

Appointments in Swarthmore College have been made as follows: George William Lewis, assistant professor of mechanical engineering; Scott B. Lilly, assistant professor of civil engineering; Howard C. Potter, instructor in engineering; Herman Pritchard and John Pitman, assistants in mathematics.

Dr. Guy H. Shadinger has been appointed professor of chemistry at Dickinson College.

Robert H. Baker, A.B. (Amherst), Ph.D. (Pittsburgh), has been appointed acting assistant professor of astronomy at Brown University.

Dr. Bird Thomas Baldwin, lecturer on education at the University of Chicago, has been appointed associate professor in education and head of the School of Practise Teaching at the University of Texas.

Edith M. Twiss, Ph.D. (Chicago), has been appointed assistant professor of botany in Washburn College, Topeka, Kan.

Dr. Fritz Pregl, of Graz, has been appointed full professor of chemistry at Innsbruck.

DISCUSSION AND CORRESPONDENCE

A COMPARISON OF METHODS FOR ESTIMATING FAME

Several communications have appeared recently in Science regarding various methods of rating men in position of eminence. Liming, the latest contributor,[1] dwells particularly upon the value of the space and adjective methods, considering these to be best in point of efficiency. In the present article I wish to mention several other possible methods for determining the relative positions of men in point of renown.

Since there is no fixed standard by which degree of renown can be measured, "historiometry" so called can never aspire to the

[1] Science, N. S., XXXII., 157.

name of an exact science. Fame is exemplified in a multitude of forms. The relative position of two men as regards celebrity may be determined not only by comparing the lines of print or the number of eulogistic adjectives in a biographical sketch; it may be found as well by comparing the number of their portraits and statues in private and public places, or the number of streets and squares and parks, which bear their names, or the number of infants christened in their honor, or the number of brands of cigars, etc., which bear their effigies as trade marks, or in a host of other ways. Each one of these forms by which fame is exemplified carries a certain weight in the establishment of notoriety; the larger the number of objective methods employed, therefore, in reaching an estimate the more nearly do we approach the average opinion of mankind at large. And after all this labor of comparing and averaging the most discouraging feature of historiometry remains, viz., the judgment which is formed in the case of recent men and events may be reversed in generations to come; centuries must elapse before an estimate of this kind can attain a permanent value.

Methods of determining fame may be illustrated best by taking a typical case. I have chosen for this purpose the determination of the relative position as regards celebrity of the two Greek dramatists Sophocles and Euripides. The two poets named lived together the greater part of their lives in the same city; they were surrounded by the same influences, produced each about one hundred plays and died within the same year. In their competitions for the dramatic prize Sophocles was awarded first honors by the Athenians twenty times and Euripides four times. As far as the judgment of contemporaries goes Sophocles might be considered therefore to be five times as eminent as Euripides.

One of the best rapid methods for determining degree of celebrity is a good reference index to the works of the world's great writers. A comparison of the ratios of the number of references to two men in the works of such writers as Plato, Aristotle, Plutarch, Cicero, Montaigne, Goethe, Carlyle or Emerson, will give a very good idea of the position of these two men in matter of renown. A comparison of the number of references to Sophocles and Euripides made by several writers shows the following:

Writer.	Number of References.		Ratio.
	Sophocles.	Euripides.	
Plato	4	8	1:2.0
Aristotle	16	21	1:1.3
Plutarch	84	217	1:2.6
Epictetus	5	17	1:3.4
Emerson	2	8	1:4.0
		Average ratio	1:2.66

The general estimate of the world's great writers would indicate that Euripides was over twice as eminent as Sophocles.

If the two men, who are being rated in position of renown, are poets (as in the present instance), a comparison of the number of times their verses are cited in different dictionaries of popular quotations will give an idea of their relative degree of fame. The following comparisons were made with two dictionaries of quotations.

Dictionaries.	Number of Times Quoted.		Ratio.
	Sophocles.	Euripides.	
Hoyt	6	11	1:1.8
Range	94	228	1:2.4
		Average ratio	1:2.1

Since Sophocles and Euripides each produced about one hundred tragedies, the ratio between the numbers of their extant plays will furnish a third means of comparison, the writer who was most popular and most widely copied in ancient times having necessarily the best chances of preservation. A comparison of this kind shows the following:

	Sophocles.	Euripides.	Ratio.
Extant plays	7	18	1:2.6

The greater number of extant plays of Euripides would account in part for the greater number of selections from this poet in the dictionaries of quotations.

A comparison of the number of busts and statues, which have come down from the past, offers another means of estimating the renown of the great men of antiquity. Catalogues of antiquities for two leading museums of Italy show the following:

Museum.	Number of Busts. Sophocles.	Euripides.	Ratio.
Naples, Museum of Antiquities (portico of celebrated men)	2	3	1:1.5
Rome, Capitoline Museum (hall of celebrated men)	1	3	1:3.0
		Average ratio	1:2.25

It is interesting to compare the previous estimates with that of Cattell. In the latter's list of 1,000 most eminent men[2] as determined by the space method Euripides occupies the ninety-ninth position and Sophocles the one hundred and eighty-first position—the latter being nearly twice as far distant from the first position of eminence as Euripides. While these figures do not allow us to fix the exact ratio of eminence, the relative position of the two poets in degree of renown is indicated unmistakably.

I have applied the space method to a comparison of Sophocles and Euripides, using the histories of Curtius and Grote with the following results:

Historian.	Lines of Space Sophocles.	Euripides.	Ratio
Curtius	200	773	1:3.86
Grote	38	71	1:1.87
		Average ratio	1:2.85

The mean ratio of the averages determined by the five different methods is 1:2.5, the range of value being between 2.1 and 2.9. Notwithstanding, therefore, the overwhelming number of victories which Sophocles achieved over his rival for dramatic excellence, the verdict of mankind seems to be that as far as eminence and fame are concerned Euripides is over twice as renowned as Sophocles.

The method of reference frequency may be applied not only to estimating the position of a man as regards fame, but it may be extended to determining the relative importance of his different achievements. A typical example of the latter is the problem of determining the order of Shakespeare's plays in point of eminence. An index of popular quotations from Shakespeare shows the following order of quotation frequency: first five, Hamlet quoted 191 times, Macbeth 111, Merchant of Venice 68, Julius Cæsar 63, Othello 62; last five, Coriolanus quoted 5 times, Timon of Athens 5, first part of Henry VI. 4, Titus Andronicus 3, Pericles 1. The above not only confirms the opinion of Goethe and other critics as regards Hamlet, which excels the other plays of Shakespeare as much as Shakespeare himself excels other dramatists, but it also bears out the general verdict concerning Pericles, which, in the words of White, "is too clumsy, too feeble, too monstrous, too revolting to be an original work of Shakespeare." It would be difficult to find another rapid objective method by which the plays of Shakespeare could be arranged in order of eminence.

Reference frequency of persons, books, works of art, events and all other subjects as determined from indexes to standard works, or indexes of current literature, or library catalogues or other means of reference, constitutes one of the best methods for determining rank in point of celebrity. Its great advantage is the quickness with which one can arrive at the combined judgment of many minds. The method admits of great extension in its manner of application and is recommended to those interested in the pursuit of "historiometric" research.

C. A. Browne

[2] *Popular Science Monthly*, 1903, p. 359.

SCIENTIFIC BOOKS

Concealing-colors in the Animal Kingdom: An Exposition of the Laws of Disguise through Color and Pattern, being a summary of Abbott H. Thayer's Discoveries. By Gerald H. Thayer. New York, The Macmillan Co.

By far the most important single contribution that has been made to the much-discussed matter of animal coloration appears under the above title. In an introduction, Abbott H. Thayer, whose "law underlying protective coloration" (1896), with subsequent additions and enlargements, has now become a part of the literature of the subject, and of which the present elaborate volume is the logical amplification, gives a succinct summary of the main features of the book, and outlines the psychological view point from which the succeeding observations are made. An artist of the high-

est attainments, whose whole life is made up of studying the visual aspects of all objects, and with a mind singularly free from preconceived ideas acquired from the study of "cabinet natural history," he is the most authoritative exponent of this phase of nature that could be chosen. Indeed, it has been the lack of this training of the mind through the eye —rather than the reverse operation—that has proved the stumbling-block of such exhaustive students and observers as Wallace and Darwin. Thus it has remained for the painter-naturalist to discover the all-underlying truths of protective coloration. Mr. Thayer and his truly gifted son have spent some eight years in the preparation of this work (which they modestly call an introduction to the study) during which they have unremittingly prosecuted their search for the truth in New England, in the West Indies and in Trinidad. Thus they have had full opportunity to study in nature what they here so lucidly unfold.

Without careful study of this introduction the reader will find it difficult, at times, to take at face value some of the statements which follow in the amplified text. Perhaps the essence of the whole book is this: "Thus, at these crucial moments in the lives of animals, when they are on the verge of catching or being caught, *sight* is commonly the indispensable sense. It is for these moments that their coloration is best adapted, and when looked at from the view point of enemy or prey, as the case may be, proves to be obliterative." Thus an animal may wear a garb vividly conspicuous at most times, when its *senses* may protect it in the open (like the zebra) for the sake of the crucial moments of foaling or drinking in the brush or brakes, when necessarily exposed to the danger of lions or whatever enemy. This of course goes against the accepted theory of natural selection, "which is based on the belief that organisms are susceptible of modification limited only by the duration of the circumstances causing it, or by the attainment of ultimate perfect fitness to environment."

In almost every phase of which the book treats, the direction of inquiry is new, and the authors demand of the reader an open mind, free from preconceptions. This must result, as in all pioneer fields, in the forming of an opposition, armed with an array of "conspicuous" creatures, nearly all of which the authors, with an understanding of the true values of out-doors light and color and environment, find it easy to render if not utterly invisible, at least far from conspicuous. At many out-doors demonstrations given before companies of scientific men, the optical delusions produced—at short distances—by as closely following nature's methods as the painter's artifices could achieve, the invariable result has been the open acknowledgment of mistaking the preconceived for the real appearance of the creature.

Gerald Thayer, in amplifying his father's discoveries, builds up a wonderful structure of new conceptions, most beautifully illustrated with paintings by his father, himself and a number of willing assistants, as well as by a mass of widely and well chosen photographs from nature, contributed by a score or more of naturalists in different parts of the world. The assertion that, in the ultimate, all patterns and colors on all animals will be found to be obliterative at the moment of greatest importance to the wearer is supported by illustration—generally convincing and always beautiful, and often picturing the most conspicuous and bizarre design dissolved in a beautifully true landscape. In the plates showing the wood drake the bird was painted very literally from a mounted bird out of doors, and the delightful setting in each case painted by simply transposing the *exact* color-notes from the bird to their positions in the landscape—a fact which escapes the reader who looks casually at the plates. Thus, too, other of the color-plates are almost sure to be misunderstood if hastily viewed, to the great injustice of the thought with which the book is throughout prepared.

In the first few chapters the general law of gradation is developed with much fullness and

illustration, as it is the basic principle upon which all specialized types of markings must be founded, and without which no picturing of detail, however perfect, would be of any value. Tersely stated, practically all animals—birds, mammals, fishes, insects—are darker above, where they receive most light, and graded lighter and lighter toward their shaded under parts, which are paler or white. Thus the natural and inevitable shadow cast by the solid body upon its own under side is "painted off" in the only possible way, and the reflective shadow comes to nearly or perfectly match the dark, but *lighted* upper surfaces, producing on the whole creature a flat tone, in harmony with its background, upon which may be painted the various detailed devices by which nature seeks to render creatures inconspicuous. A series of models, in the form of birds, makes this all-important principle clear.

In treating the more specialized markings, much emphasis is placed on the importance of highly epitomized semi-distant vistas on the surface of forest-birds, which do not strike the exact focus of the casual eye; an extremely abundant type of marking. Ruptive and secant markings, interrupting the otherwise conspicuous profile of the wearers, form an important and frequently encountered class, and are treated at some length, as are iridescence and changeable colors. Indeed, this is one of the most delightful and enlightening chapters in this wholly remarkable book.

The chapters pertaining to mammals are the ones that will excite the widest discussion, although most if not all the contentions of the authors must be vindicated if given a full and honest test. While the fact of the high actinity of blue has much to do with the success of many of the photographic illustrations in this chapter, the easily demonstrable fact remains that white is the best average match for sky against sky. This has an important bearing with nocturnal species with large white marks on their upper surfaces, seen by prey or enemy against the sky. It is also given as the reason why all the gulls, terns and other sea birds of the open sky are so largely white: not that they are invisible against the sky, but that white is as near sky-color as anything that can be got, and therefore the best that can be done.

Fishes come in for an elucidating chapter, as do the reptiles, batrachians and invertebrates. Here, especially among the insects, we have the most beautiful and convincing evidence of the close study of the authors, and the wondrous results of it. We are shown by what elaborate means, often entailing the entire reversal of the basic gradation law, nature has managed to overcome the effects of gravity by *counter-grading* such heavy species of caterpillars as by their weight turn the food-leaves edgewise, and thus themselves hang "back-down." It is significant that the most elaborate adaptation is found during the long senseless and defenceless larval period, when swift motion and keen sight are impossible, and it is certainly among caterpillars that we find the most astounding specific resemblances to exact surroundings. This chapter is one of unbounded interest, and is followed by a discussion of butterflies and moths that is scarcely less exciting.

While the book teems with specific examples of great charm and covers the whole animal kingdom, and is therefore a complete work in one sense, in another it is truly an introduction, as claimed by the authors. For if the reader be himself open-minded, and, fired by the novelty of the discoveries, try for himself the experiments so graphically described, he will be led irresistibly to a sympathy with the enlightened authors, and there will open to him a whole new realm of discovery—he will, in short, be led back to the delightful field of philosophic and contemplative natural history, which, in these days of minute and technical study of classification and relationships, has been nearly if not quite lost sight of. The greatest value of this unusual book lies not, therefore, in the array of specific fact it con-

tains, vast though this be, but rather in its wholly enlightening effect upon the search for biologic truths, and for this alone it is worthy of deep study and a lasting place in literature.

LOUIS AGASSIZ FUERTES

Einführung in die Physiologie der Einzelligen (Protozoen). By S. VON PROWAZEK. Leipzig and Berlin, B. G. Teubner, 1910. Pp. 172.

Ever since the appearance of Verworn's excellent paper on the psycho-physiology of the protozoa in 1889, it has been the hope of many that in these supposedly simple organisms a key would be found to the solution of various perplexing problems in the higher forms; that physiological and psychological processes as well as structures would be discovered here in their very inception. Unfortunately this hope has not been realized. The life processes in the unicellular forms have been found to be exceedingly complex. Even the anatomy is far more complex than was formerly supposed. As a matter of fact the more thorough the investigation, the more intricate and involved the physiology and structure of these apparently simple creatures is found to be. Our author, realizing this, says that a protozoan "is in a certain sense a unicellular metazoan," and the establishment of this idea, he asserts, is the underlying motive of the volume under consideration.

This volume, as the title indicates, is intended to serve as an introduction to the physiology of the unicellular forms. The author says it is not a hand-book. In reality, however, it takes the form of a hand-book and might truthfully be called a very brief review or statement of results of original work bearing on all functional processes in unicellular forms. The principal topics discussed follow in the order of presentation: The structure of the cytoplasm and the nucleus, both physical and chemical; The nature and function of the surface membrane or layer and various organic bodies within the cell; Respiration; Process of feeding; Excretion; Motion and locomotion; Fertilization; Regeneration; Protection; Immunity; Responses to chemicals, electricity, light, etc.; Inheritance; Variation, and Mutation.

While the results of investigation bearing on some of these topics are fairly conclusive and present some coherence, those bearing on others are quite the opposite and the author's treatment of these necessarily consists mainly of a series of dry incoherent statements of experimental results of interest only to those who are in search of a brief account of the work done and the references to such work.

In general the author's selection and review of papers and his discussion appear sane and trustworthy. He usually presents the literature bearing on both sides of mooted questions without taking a definite stand himself. However, as might be expected in a subject as new as the physiology of the unicellular forms, he supports some conceptions which in the minds of many are erroneous. Among such may be mentioned (1) the idea that the movement of certain amœbæ can be accounted for by the effect of the environment on surface tension; (2) the idea that the activity and form of organisms is regulated by a non-energetic principle, an entelechy or a psychoid as described by Driesch; (3) the idea that unicellular forms orient and move directly toward or from a region containing certain chemicals or having a given temperature; (4) the idea that there is no selection of food in the protozoa; (5) the representation of the eye-spot of *Euglena* as a hollow cylinder.

The volume in question will no doubt be found valuable principally as a book of reference. Unfortunately, however, it is not well adapted for this use, owing to the very brief table of contents and the absence of an index, and to the fact that the titles of the papers cited are scattered through the body of the text making it difficult to locate the references referred to. Moreover, the frequent interruption in the text by titles which in many instances appear again and again annoys the reader.

S. O. MAST.

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VIII., No. 2, issued August 29, contains the

following: "The Formation in the Animal Body of *l*-β-Oxybutyric Acid by the Reduction of Aceto-acetic Acid," by H. D. Dakin. Experiments are described which show that the liver possesses a mechanism, dependent upon the antagonistic action of two ferments, by which the mutual interconversion of β-oxybutyric acid and aceto-acetic acid may be effected. It is thought probable that the β-oxybutyric acid which appears in the blood in acidosis is the result of reduction of aceto-acetic acid in the liver. The mechanism of the reactions involved is discussed. "On Decomposition of Aceto-acetic Acid by Enzymes of the Liver: Part II.," by A. J. Wakeman and H. D. Dakin. The primary product of the action of the enzyme in the liver which has been shown to decompose aceto-acetic acid is lævo-rotatory β-oxybutyric acid. "The Products Resulting from the Putrefaction of Fibrin by *Clostridium carnofœtidus, Salus* and *Rauschbrand,*" by Francis H. McCrudden. Analyses show that distinct differences exist between the putrefactive products of the organisms named which may be of diagnostic value. "The Metabolism of Some Purine Compounds in the Dog, Pig and Man," by Lafayette B. Mendel and John F. Lyman. A comprehensive, comparative study of the fate of various purines in the organism. "A Study of Enzymes by Means of Synthetical Polypeptids," by A. H. Koelker. Racemic alanyl-glycin may advantageously be used in the study of proteolytic enzymes. The rate and extent of digestion can be easily estimated by the optical method.

SPECIAL ARTICLES

FURTHER DATA ON THE HOMING SENSE OF NODDY AND SOOTY TERNS

During May and June of the present year I continued my studies on distant orientation in the noddy and sooty terns at the Tortugas colony. The report of the work done in 1907 will be found in publication 103 of the Carnegie Institution. The work in 1910 like that in 1907 was done under the auspices of the Marine Biological Laboratory of the Carnegie Institution. I wish to thank Dr. Mayer, of the laboratory, for his continued kindness to me during the past season's work.

The 1910 season was one very unfavorable for conducting experiments upon distant orientation. The spring was late in the northern temperate regions, and this, combined with the severe storms in the Gulf, seriously handicapped the work. It was often impossible to get birds to Key West in time to make connections with the Mallory steamers. The water between Tortugas and Key West is often very rough, and unless there happens to be a flat calm we never attempt to go to Key West in our small launches. Several times our experiments had to be given up for this reason, even after the birds had been captured and marked. Then, too, after every important release (Galveston, New York and Mobile) adverse winds set in against the birds.

By far the most serious defect in the work was the failure until towards the very last to perfect a favorable technique for shipping and feeding the birds. In 1907 the orientation work was incidental. In 1910 it was the principal feature. For this reason it was desired to make large shipments. The method adopted in all cases was to capture and mark about twelve to fourteen birds, put them into one large hooded cage and give them in charge of a capable employee of the laboratory, who would accompany them on the trip and release them at the proper time. Minnows, when they could be obtained, were purchased in Key West and put in the ice chest of the Mallory boat. At times when they were not obtainable, large fish were carried and cut up into small pieces and fed the birds in the place of minnows. This latter method is not nearly so satisfactory, since many of the birds will refuse chopped fish when they will not refuse minnows. The most serious mistake made was in sending too many birds in one cage. They could not be given individual attention. Many died on the way, either from starvation or else were trampled to death. The birds apparently have an instinctive tendency to perch. Some get seriously lacerated through having others climb up and perch upon them. In carrying

birds back with me for presentation to the Bronx Zoological Park, I found that they could easily be transported if the large cage were subdivided into small individual compartments. Each bird could be taken out and fed and if it refused to eat could be forced to eat. In carrying out further experiments, this latter method alone will be adopted. If minnows can not be obtained in Key West for the trip, the experiment will be abandoned. Individual compartments and a good supply of minnows will insure the healthy arrival of a group of birds in New York, Galveston or Mobile. Birds were conveyed to all these places during the months of May and June, but the above technique was not adopted and none reached these ports in good condition. The details of these releases will follow.

Flight from Key West.—On May 18, twelve noddies, twelve sooties and four man-of-war birds were sent to Key West. It was originally intended to ship them to Galveston, but connection was not made with the Galveston boat. Accordingly all these birds were released in Key West harbor, 65¼ miles due east of Bird Key. The weather was stormy. They were released at 2.30 P.M. All twelve of the noddies returned, but the time varied from 17½ hours to 2 days, 15 hours. Ten of the twelve sooties returned. Three returned in 17½ hours, approximately. Two required one day, 20½ hours, while the others required five, six, eight, nine and eleven days, respectively. Thus twenty-two out of twenty-four birds returned, but the time was long. I am inclined to think that the longer time required for the sooties was due to the fact that their nesting neighbors would not allow them to approach the nest (on account of the markings). The flight is interesting in showing that the retention of nest locality and nest mate is still perfect at the end of eleven days. It is of further interest in showing such a large percentage of returns. Two of the four man-of-war birds returned, but the time can not be accurately stated. One was first seen at the end of seven days, the other somewhat later. Since the man-of-war bird does not nest on the island it is only by accident that a marked bird can be singled out of the group of five hundred which roost there.

The Release in New York Harbor and en Route.—On the night of May 20 (10.30 P.M.) the Mallory boat *Concha* left Key West carrying two lots of birds in charge of Mr. Wilson. One lot was to be released at an intermediate distance between Key West and New York and *at night*. The other lot was to be released in New York harbor. The first lot contained four sooties. They were released at 7.30 P.M., 365 miles from Bird Key. One bird returned at the end of four days. A second one returned at the end of about five weeks (Mr. Wilson noted the return of this bird after I left the island. He may have made some mistake in noting the bird. It is better to look upon this return as only probable). The second lot of birds containing five noddies and six sooties were released in New York harbor at 4.30 P.M. in a fog. Since no minnows were obtained for this long trip, the birds were in very poor condition. All of the birds flew about two hundred yards out from the ship and alighted upon the water. This they never, or rarely, do, naturally. In their weakened condition I doubt if any ever arose from the water. None returned to Bird Key. Even had the birds been able to fly back into milder waters (where they could have obtained food probably for the first time) they would have had to contend against adverse winds.

Galveston and en Route.—Two lots were sent out. The first to be released about 500 miles out, the second in Galveston harbor. The birds were captured May 29. They were sent in the laboratory launch *Physalia* to Key West on May 30. They left (Mr. Wilson in charge) in the Mallory boat *Concha* at twelve noon June 1. The first lot of birds containing three noddies—two having died in passage—and four sooties were released Friday, June 3, at 4.45 A.M. in the open waters of the gulf. The *Concha* was then 470 knots from Key West. Bird Key is 60 knots to west of Key West. This distance has to be subtracted, leaving 410 knots, or approximately 460 miles. (The birds had really traveled nearly

600 miles). Two of the three noddies returned at the end of three days against heavy winds. None of the four sooties returned, which is to be expected since my experiments show that the sooty can not spend the night on the water and remain in good condition. This return of the two weakened noddies over water is to my mind the most wonderful flight on record. There is neither a stick nor a stone which might serve as a visual landmark between Bird Key and Galveston.

Several of the original lot of both noddies and sooties died on the way to Galveston. Six noddies and five sooties survived. They were released on Saturday, the fourth, at 5 A.M. They were very weak and flew a short way to the shore and alighted there. None of these birds returned to Bird Key. Mr. Wilson remained in Galveston until the following Wednesday, June 8. On the homeward trip he noticed one marked sooty resting on a piece of driftwood, approximately 400 miles out from Galveston. The red marking of the bird was plainly seen with the naked eye and was still more clearly seen with the aid of the field glass. The sooty is uncommon in those waters and Mr. Wilson has been familiar with the noddy and sooty terns for years. I think his observation is wholly reliable. That this bird should have reached this distance on the homeward route is remarkable. The distance from Galveston to Bird Key is approximately 800 miles. Since the sooty in all probability can not remain in the water over night, and since it is improbable that floating driftwood can always be found when the bird is fatigued, the failure of these birds to return over the open water for 800 miles is not to be wondered at. Adverse winds were again in evidence upon this trip.

The Release at Mobile.—Seven noddies and seven sooties were sent to Mobile on June 4 in charge of Captain Lumblum. For some reason the birds did not thrive and five out of the fourteen died in passage. The others were in poor condition. The birds were hardly more than released before a heavy head wind set in, which culminated in a storm so severe that all hope was given up of their return. None returned within the limits of my stay.

As a net result of my work then on the homing sense, we have a failure of returns from New York, Galveston and Mobile; we have one sure return, and another probable one from a night release off the northern coast of Florida, 362 miles from Bird Key; we have two noddies out of three returning from a distance of 460 miles over open water in three days against an adverse wind; and a probable partial return of one sooty from Galveston. However, we gained the needed experience in crating and in caring for the birds which will insure a successful continuation of the work at some later time.

Experiments to Determine the Rapidity of Flight.—Three noddies and one sooty used in the above flight from Key West were again captured and sent to Key West (65¼ miles away). They were captured on the night of June 16 and released at 1.25 in Key West, June 17. They returned to Bird Key that same afternoon, together, at 5.45. They returned just as the other birds were coming in from the feeding grounds. They probably stopped to feed as soon as familiar waters were reached.

Experiments to Test Cyon's Hypothesis of Special Nasal Sense.—Cyon's hypothesis to the effect that pigeons utilize a special nasal sense in homing is too well known to require discussion.

Three noddies were captured on the evening of June 16 and confined in small cages until daylight of the following morning. At daylight I closed the anterior nares of these birds tightly with wax and then coated the surface heavily with asphaltum, tying the legs of the birds for several hours until the asphaltum hardened. Two of the birds I sent to Key West in a hooded cage by the laboratory launch. The control bird was kept until the launch was due in Key West. It was then carried to Loggerhead Key, some three or four miles distant and released. It returned immediately to its nest and resumed its normal activities.

The other birds were released in Key West

harbor at 1.25 P.M.. Both were on their nests at daylight of the following morning. In all probability they returned in the evening of the previous day (that is, on the same day they were released). I recaptured these birds and found that the nares were still perfectly closed. The asphaltum had not been even scratched. Both birds were in splendid condition.

Experiments to Test the Water Habits of Terns.—In my previous report I made the statement that the terns are never seen in the water, unless they fall in by accident. I made no experimental test in 1907 of their conduct when forced to remain in the water. It is especially desirable in homing experiments to know whether these birds can rest on the water over night and still fly up from it in the morning. For example, the flight of 800 miles from Galveston to Bird Key can not be made in a day, and unless the bird can rest on the water at night they must perish. Exhaustive tests were made by placing a large wire cage in the water and confining the birds therein. I quote an experiment in detail.

Two noddies and two sooties were placed in the cage at 5.15 P.M. All the birds alighted on the surface of the water and then flew up and struck against the sides of the cage. Both noddies and sooties swam easily. The noddies seemed very much at home in the water. Their swimming movements were graceful and well coordinated. When alighting upon the surface of the water they folded their wings tightly against the body and held the breast and tail feathers high above the surface of the water.

The sooties on the other hand, arose and alighted clumsily. They kept their head and tail barely out of the water. Sometimes, indeed, the wings were stretched out in a very awkward way. In about two hours the birds became quiet, and ceased to fly against the sides of the cage. The noddies made just as vigorous efforts to get out as did the sooties. It soon became too dark to distinguish the birds and I then left them undisturbed until 8.30 in the morning of the following day. At that time *both noddies* were in *first class condition,* and were swimming as easily as when first placed in the water. I opened the cage and both birds swam out and arose from the water.

One sooty was *dead.* The other was just *barely alive.* The feathers of this bird were all water-soaked. It was shivering with cold. It could neither swim nor fly. I carried the bird to the shore and put it in the sun, where it remained motionless for nearly two hours, and then flew away. I have repeated these experiments again and again and always with essentially the same results. I then modified the experiment slightly by tying small wooden floats ($\frac{3}{8}$ inch thick and 6 inches square) in such a way that they remained in the center of the cage, regardless of the tide. Under these conditions the birds, both noddies and sooties immediately utilized the floats, and remained resting upon them making few efforts to escape. Even the sooties are in perfect condition after a night spent in this way.

It seems well established by these experiments that the noddy can spend a whole night in the water and be little the worse for it, but that the sooty must perish unless floating driftwood or other objects afford it a resting place.

JOHN B. WATSON
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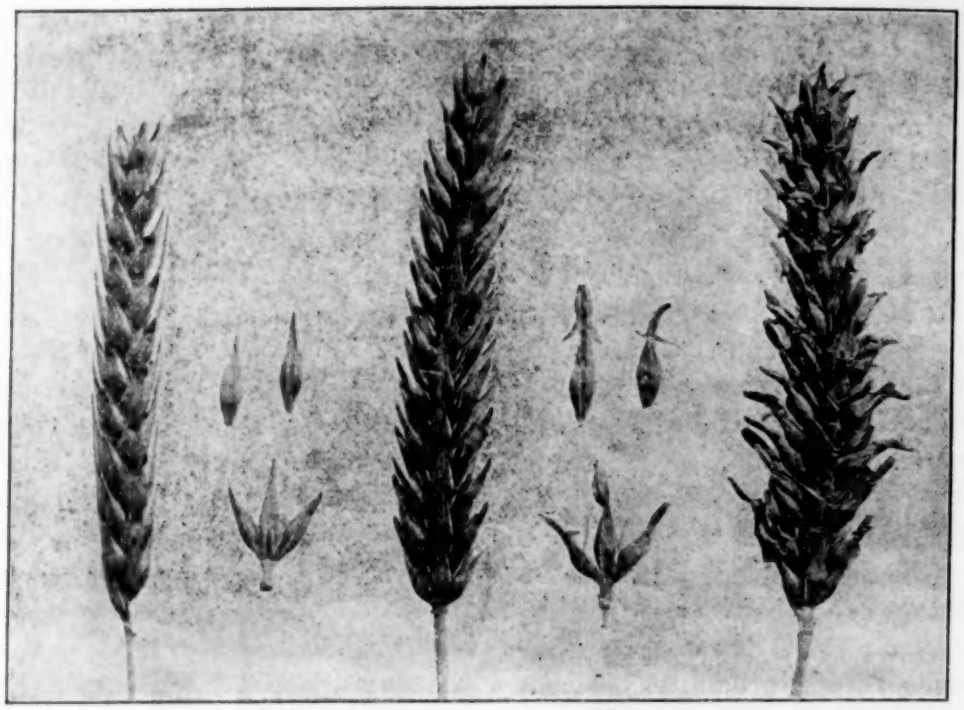
A NEW AWNLESS BARLEY

A NEW and distinct type of awnless winter barley has been developed by the Office of Grain Investigations of the Department of Agriculture. It differs from the beardless barley now cultivated in that there is no appendage on the glume. This variety is a selection from among a large number of hybrids produced from a cross between Tennessee Winter, a white six-rowed variety (*Hordeum vulgare*), and Black Arabian, a black two-rowed variety (*Hordeum distichum*). In the third generation a peculiar form appeared in which the median spikelets contained awns from three to four inches long, while a few of the lateral spikelets contained rudimentary grains with short awns. These short-awned rudimentary grains were planted separately in



a *b* *c* *d* *e*

a, side view of head of new awnless barley; *b*, separate grains and spikelet; *c*, front view of the head; *d*, separate grains and spikelet of hooded barley; *e*, head of hooded barley.

the fall of 1907 and in 1908 produced heads similar to those in 1907 with the exception that on one plant were heads on which the greater portion of the lateral spikelets contained perfect kernels with short awns. The short-awned kernels from each head were planted in separate rows in the fall of 1908, and the plants produced from one of them in the summer of 1909 contained heads upon which all of the spikelets were fertile, the heads being six-rowed, with large plump grains without awns. The entire progeny was planted separately in the fall of 1909 in a head-to-row test, and of the several hundred heads produced in 1910 99 per cent. were of the awnless type. As this reduction of the awns was progressive and the heads have been awnless for two seasons, it is believed that the type is fixed. The variety has been named "Arlington." The fact that there is already a so-called type of beardless barley in existence will cause some confusion. It is proposed, therefore, that the name "hooded barley" be used for the old type, and this name will hereafter be used by the Office of Grain Investigations. The name beardless will only apply to the new hybrid. The photograph illustrates both types.

H. B. Derr

THE AMERICAN CHEMICAL SOCIETY SAN FRANCISCO MEETING

A general description of the meeting has already appeared in Science. The usual abstracts of papers have been delayed in publication, owing to the loss of a trunk in transit which contained many of them and has but recently been found.

The general session of the society was held at the St. Francis Hotel on Wednesday morning, July 13, at which the following papers were presented. An abstract of the last paper is the only one received.

Positive Photography: W. D. Bancroft. (Illustrated with lantern slides.)

Liquid Ammonia as a Solvent and the Ammonia System of Acids, Bases and Salts: E. C. Franklin.

Chemistry in the Bureau of Standards: W. F. Hillebrand.

The Use of Sodium Benzoate as a Preservative of Food: H. E. Barnard.

To warrant its use in foodstuffs a preservative must possess certain characteristics. It must not injure the health of the consumer; it must not facilitate careless methods of manufacture; it

must not allow the use of unfit raw material; it must be non-irritant; it must not retard the action of the digestive ferments; it must be an efficient preservative; it must not decompose into more active substances than itself. Sodium benzoate does not meet these requirements and its use is attended with so many disadvantages that it should not be allowed in foodstuffs.

Following the general session the society met as usual by divisions. The Division of Fertilizer Chemistry and the Sections of Biological Chemistry, Chemical Education and Chemistry of India Rubber held no meetings. Biological papers were therefore presented before the Division of Agricultural and Food Chemistry. Divisional meetings were held on July 14, 15 and 16 with programs as follows:

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

The Saccharimeter Scale and the Means of its Verification: C. A. BROWNE.

The various standards for the saccharimeter scale are described; methods of verifying scale divisions of a saccharimeter by means of quartz plates, the control tube and c. p. sucrose are given. The author has recalculated the sucrose values of the saccharimeter scale, using Landolt's formula and shows that the maximum error due to change of concentration is only 0.01° V. The table of Schmitz which shows a maximum error of 0.08° V. is erroneous. The statements of manufacturers that the wedge surfaces of saccharimeters are plane and the scale divisions equidistant are verified by practical tests upon modern instruments. The maximum error of graduation due to imperfections of quartz were not found to exceed 0.05° V. upon two saccharimeters and were usually considerably within this limit. The relation between the French and German normal weights for sucrose according to measurements made upon a Laurent "plaque type" was 26 gms. to 16.29 gms., which agrees with the weights officially prescribed in Germany and France.

The Normal Weight of Dextrose: C. A. BROWNE.

The normal weight of dextrose for a saccharimeter, using the Ventzke scale, is given by different authorities as between 32.5 and 33 gms., according to the concentration of dextrose in solution taken as a basis of calculation. The author believes that the weight of pure dextrose, which, dissolved to 100 true c.c., will polarize exactly 100 at 20° C., should be taken as the normal weight. The value thus calculated, using Tollen's formula, is 32.25 gms. The actual dextrose value of the scale divisions of the saccharimeter, using this normal weight, is found by means of a table or a formula, which is correct for variations in specific rotation due to concentration. The advantage of using this method is that the per cent. of dextrose is found at one operation without the necessity of making a preliminary assay of material to determine the exact quantity necessary to be weighed out.

On the Oxidation of Pyrogallol by Hydrogen Peroxide in the Presence of Plant Extracts: H. H. BUNZEL.

Evidence is given that the oxidation of pyrogallol to purpurogallin by hydrogen peroxide in the presence of plant extracts takes place in two stages. The first is carried on by the hydrogen peroxide, the second by the oxidizing enzyme in the plant extract.

Detection of Lemon Oil in Orange Oil: E. M. CHACE and A. R. ALBRIGHT.

The method employed depends upon the difference in the refractive indices of the aldehydes contained in lemon oil and in orange oil. The aldehydes are separated by formation of double sulphite compounds, which are decomposed by means of sodium carbonate and caustic soda under ether. The ether is evaporated and the refractive index of the remaining oil taken after drying and thorough purification. It is found that the refractive index of the aldehydes from lemon oil are almost identical with citral, while the aldehydes from both sweet and bitter orange oil are very much lower. The method is only very roughly quantitative.

The Influence of the Ingestion of Spices upon the Excretion of Hippuric Acid: H. E. BARNARD.

It has long been known that hippuric acid formerly found in the urine of man and in larger quantities in the urine of the herbivorous animals is produced by pairing of glycocol with benzoic acid. The origin of the benzoic acid eliminated as hippuric acid has usually been attributed to the ingestion of plant foods, fruits, etc., in which benzoic acid sometimes occurs naturally.

It has also been stated that the ingestion of spices containing essential oils of the aromatic series induces the increased excretion of hippuric acid, and to determine this point the hippuric acid was determined in the urine of seven subjects for four days, during which time the subjects ate normal food, and later for seven days when each subject was taking a bottle of

catsup per day. The results showed no increase in hippuric acid excretion during the period when the tomato catsup was taken. The theory that the essential oils of spices are oxidized to benzoic acid is not sustained.

A careful study of the Bunge-Schmiedeberg method of determining hippuric acid showed the method as modified by Dakin to give accurate results.

The Reactions of Lime and Gypsum on some Oregon Soils: C. E. Bradley.

The soils of western Oregon respond very readily to applications of gypsum. Tests on a number of these soils with lime and gypsum under different conditions indicate that gypsum here acts as an indirect potash fertilizer, while lime does not.

Environmental Studies on Wheat: H. W. Wiley and J. A. LeClerc.

This paper contained a review of past work carried on in the bureau of chemistry on the influence of environment on the composition of wheat. The results showed that there was a larger difference in per cent. protein and weight per thousand grains between the same variety of wheat grown in different localities than between different varieties grown in the same locality. The average difference in nitrogen content between different varieties grown in the same locality is 0.69 per cent., the variation being from .11 to 1.25 per cent. This is based on 514 samples. The average difference in nitrogen content in the same variety grown in different localities is 1.23 per cent., the variation being .47 to 2.17 per cent. This is based on 449 samples representing forty varieties. There is no marked difference in ash, fat, fiber, pentosans or sugar between high and low nitrogen wheats. The length of the whole growing period influenced the nitrogen content, a long period of growth producing low nitrogen wheat, and *vice versa*.

The Translocation of Plant Food and Elaboration of Plant Material during Germination of Wheat: J. A. LeClerc and J. F. Breazeale.

At two days old when the germ of 100 seeds weighed about .2 grams, *i. e.*, about 6 per cent. of the weight of the seed, the plantlet contained 42 per cent. of the total potash, 23 per cent. of the nitrogen, and 17 per cent. of the phosphoric acid. The formation of fat, fiber, sugars and pentosans was studied throughout the growing period. The fat in the seed decreased 30 per cent. in four days, after which there was no further decrease, thus showing that there had been no absorption of non-embryo fat of the seed into the plant. A small amount of fat was elaborated by the plant.

After fifteen days the residual seed contained about the same quantity of fiber as was originally present in the seed. The plantlet, however, formed six to seven times as much fiber as was present in the seed.

The residual seed gradually loses pentosans until less than half the original amount is present at the end of fifteen days. In the plant the amount of pentosans increased up to the tenth day, then decreased slightly. Cane sugar gradually decreased in the residual part of the seed until none was present at the end of the fifteenth day. In the plantlet, invert sugar increased up to the ninth day, when it contained three times more than the amount of total sugar of the original seed, and then decreased to the fifteenth day. The cane sugar of the plant increased to the twelfth day and then decreased. The decrease of sugars is probably due to their conversion into pentosans, part of which are later converted into fiber.

Time Factors in the Determination of Nitrogen and other Observations on the Kjeldahl Method: P. L. Hibbard.

Organic substances such as blood or bone have their nitrogen completely converted into ammonia by boiling three hours with 25 c.c. of sulphuric acid, 10 grams potassium sulphate and ½ gram copper sulphate; in most cases.

In distillation of this digestion practically all the ammonia is obtained in less than fifteen minutes.

Bumping of the digestion is prevented by addition of one to two grams ferrous sulphate.

Using the Ulsch-Street method, only a few minutes are required to change the nitrogen of nitrates to ammonia.

During the acid digestion loss of ammonia occurs when a large portion of the acid has been driven out by too much or too long-continued heat, but not because the flask is heated by the bare flame above the level of the acid.

Composition and Digestibility of the Fat of Cowpea Hay: G. S. Fraps and J. B. Rather.

The ether extract of cowpea hay has a digestibility with sheep of approximately 30 per cent. It contains over 50 per cent. unsaponifiable matter. The fatty acids have a digestibility of approximately 90 per cent. The unsaponifiable part

of cowpea hay is only slightly soluble in water, but approximately 40 per cent. of the ether extract of the excrement is easily soluble in water. Full details and conclusions will be published elsewhere.

Determination of Ammonia Nitrogen in Water in the Presence of Hydrogen Sulphide: E. BARTOW and B. H. HARRISON.

To the water containing hydrogen sulphide 50 c.c. of normal sulphuric acid was added and 100 c.c. of water distilled over. 50 c.c. of normal sodium hydroxide was then added and ammonia determined by distillation and nesslerization. The hydrogen sulphide did not interfere with the ammonia determination and the addition of sulphuric acid was shown to have no appreciable effect on the regular determination of free and albuminoid ammonia.

Extent and Composition of the Incrustation on Filter Sands: E. BARTOW and C. E. MILLAR.

Examinations were made of sand from five water purification plants in Illinois which use lime and sulphate of iron as a coagulent. By means of acid from 13 to 84 per cent. of incrustation was dissolved. This is equivalent to an increase of from 16 to 650 per cent. in the weight of the original sand. As the amount of sand in the beds was not increased, an amount of sand equal to the soluble matter has passed into the sewer. The soluble matter consisted of from 86 to 96.5 per cent. $CaCo_3$.

High Protein Bread: J. A. LECLERC and B. R. JACOBS.

The results of baking tests show that a well-piled loaf, of fair size, attractive in appearance, and palatable, can be made out of 25 per cent. cotton-seed flour and 75 per cent. ordinary flour. The protein content of such cotton-seed bread is over 14 per cent., while of bread made from ordinary flour it is under 9 per cent.

A Note on the Hypoxanthine of Meat: C. B. BENNETT.

When fresh rabbit meat, or meat coagulated by heating to 75° C., is extracted with water and the filtrate treated with barium hydroxide and basic lead acetate, almost no hypoxanthine is obtained in the final filtrate. Meat left standing in a chamber of ether, or in water for a few days, and then subjected to like treatment, gives much more hypoxanthine. It is concluded that hypoxanthine is in a combined state in fresh meat and is liberated on standing raw, but that heating almost stops this action.

On the Unification of Soil Analysis: E. W. HILGARD.

This paper, while insisting strongly upon the practical need of soil analysis for the determination of permanent soil values, deplores the lack of uniformity in the method of preparing the soil extract, whereby comparisons are rendered difficult or impossible, and an enormous amount of work is wasted. In view of the hopelessness of any international agreement upon arbitrary prescriptions, the adoption of a *natural limit* of extraction, by the action of strong acids—preferably hydrochloric—is recommended; according to the author's experience, the results of such analyses lend themselves to practical interpretation *at least* as readily as those by any other method.

Quantitative Chemical Analysis of Animal Tissue —V., Estimation of Chlorine: W. KOCH.

The estimation of chlorine, either by analysis of the total ash or by direct water extraction in tissues rich in lipoids such as the brain or liver, can hardly be said to yield results of any degree of accuracy. In the ash the chlorides are often replaced by sulphates or phosphates derived from the burning of organic combinations of these elements. A watery extract of a tissue like the brain can only be filtered with the greatest difficulty and the complete extraction would be almost impossible.

In connection with the methods previously outlined under the above general title it was found that the chlorides all pass into the fraction 2 or the alcohol soluble fraction. By precipitating the lipoids in this fraction without chloroform and with nitric instead of hydrochloric acid a solution is obtained in which the chlorides can be titrated direct by Volhard's method. The estimation of chlorine can be thus combined with that of any other tissue constituent described in these methods. Some results obtained on the brain are given below:

	Whole Brain		*Corpus Callosum*	
	In per cent. of moist tissue	In per cent. of dry tissue	In per cent. of moist tissue	In per cent. of dry tissue
Case 74	0.20	0.89	——	——
Case 75	0.16	0.71	0.15	0.48

A Convenient Drying Oven: M. M. MACLEAN.

An oven for small laboratories made of two thicknesses of thin sheet iron with asbestos board between; heated by incandescent lamps, the temperature controlled very accurately by thermostat device.

The Constituents of the Wax of Candelilla or Mexican Wax Plant: G. S. Fraps and J. B. Rather.

A hydrocarbon was isolated from this substance, melting at 68°, not very soluble in cold ether or chloroform, soluble in hot, difficultly soluble in hot or cold alcohol. It is probably hentriocontane, $C_{31}H_{64}$, which has also been found in beeswax. Two other bodies were separated but have not yet been identified.

A Polariscopic Method for the Determination of Malic Acid and its Application in Cane and Maple Products: P. A. Yoder.

Making use of the fact that uranyl compounds cause a manifold increase in the optical activity of active dicarboxylic hydroxy-acids, the author has developed from extensive original data a method of estimating malic acid in solutions which may at the same time contain a wide range of other substances. The rotatory power of the uranium-malic-acid compound was found, for a 1 per cent. solution to be $-29.7°$ Ventzke for white light and $-28.9°$ Ventzke for yellow light, while that of the malic acid itself in a 1 per cent. solution is -0.13. Letting P = the polarization before and P' that after the addition of uranyl acetate, t = the temperature C. and L = the length of the polarization tube in dcm., then, with yellow light

per cent. mallic acid =

$$\frac{(P'-P)\times[1+0.001(t-20)]}{-28.8\times\frac{1}{2}L}.$$

For white light substitute 29.6 for 28.8 in the formula.

Strong mineral acids in the free state or an excess of alkali interfere. Any degree of acidity (concentration of H ions) through the range between the two standards: (1) one third N acetic acid, and (2) one third N acetic acid with one fourth of it neutralized with KOH, is favorable for maximum activity. This degree of acidity may be established in a solution by adding acetic acid or KOH until, with methyl orange as indicator, a shade is produced between the shades caused by the above two standards. Or the maximum rotatory effect is found by successive additions of acetic acid or KOH to the solution in the polarization tube and trial polarizations after each addition. A tubulated polariscope tube of special construction is suggested for these trials. At least 1.25 atom U should be present for each molecule malic acid, and more in the presence of certain other organic acids. To separate malic acid from syrups, either precipitate with lead acetate and 3.6 volumes 95 per cent. alcohol for each volume of water, liberating the acid from the lead by H_2S, or precipitate with barium acetate and 14 volumes 95 per cent. alcohol for each volume of water, dissolving then the barium malate in water to separate from the sulphate, phosphate, etc. Add to the barium malate solution acetic acid to get the maximum rotatory activity.

Two cane syrups had 0.02 and 0.04 per cent., respectively, and four samples of maple syrup had 0.49, 0.32, 0.26 and 0.51, respectively, of malic acid.

By a similar method for d-tartaric acid, polarizing with white light and at 27.5° C.,

$$\text{per cent. tartaric acid} = \frac{P'-P}{25.16\times\frac{1}{2}L}.$$

For a mixture of tartaric and malic acids, if n = total c.c. N alkali required to neutralize 100 c.c. of the solution, and m = change in polarization in degrees Ventzke in a 20 cm. tube with white light and at 27.5° C., then

per cent. malic acid $= 0.03287n - 0.01741m$, and

per cent. tartaric acid $= 0.03824n + 0.01949m$.

Notes on the Determination of Acids in Sugar-cane Juice: P. A. Yoder.

Data are collected upon which to base methods of separating, estimating and identifying organic plant acids. By a simple form of apparatus improvised by the author, the succinic, aconitic and lactic acids are readily extracted by ether from their water solutions. The malic, citric and tartaric acids go over into the extract very slowly. Solubility or precipitability tests were made with the calcium and certain other salts of these acids. As a means of identifying citric acid, Denigè's acetone dicarboxylic acid reaction is very delicate for citric acid, giving, however, the same results with the preparations of aconitic acid that were on hand.

In a sample of cane juice partly analyzed were found, per 100 c.c. fresh juice, 0.00314 g. phosphoric, 0.00004 g. oxalic, 0.00077 g. malic and about 0.05 g. aconitic acids. Sulphuric acid was also present. Tartaric, succinic and citric acids were absent.

Biochemical and Toxicological Studies upon a Number of Species of Penicillium: C. L. Alsberg and O. F. Black.

The moulds of the genus *Penicillium* have been

regarded as the chief organisms which spoil corn in such a way as to cause it to produce pellagra when consumed by badly nourished, wretchedly poor peasantry living under poor hygienic conditions. It has been reported by a number of Italian investigators that these moulds produce toxic substances, and it is believed that these substances are phenol acids. This belief is based not upon the isolation and identification of these substances, but upon the fact that extracts of the cultures gave red or violet colors with ferric chloride. However, not all investigators have been able to obtain toxic extracts from cultures, or extracts giving a positive reaction with ferric chloride. Hence, the whole question whether or not *Penicillium* produces toxins when growing upon corn, and whether or not this organism has anything to do with the production of pellagra, is still unsettled.

It has occurred to the authors that the discrepancy in the results obtained by various investigators may possibly be due to the fact that the organisms which each investigator studied may not have been identical. Very recently there has appeared from the department of agriculture a publication by Thom,[1] in which for the first time the fungi of this genus have been adequately studied from the systematic point of view. It is therefore now possible to investigate each species separately. The authors are engaged upon the investigation of the biochemistry of different species of *Penicillium* which have been obtained from Thom, and which Dr. Erwin F. Smith has been kind enough to grow. Great differences have been found in the products of five of the species investigated so far. Of these five but one gives a positive ferric chloride reaction, and the toxicity of the extracts varies greatly for the different species. The authors are engaged upon a detailed study of the products produced by these organisms, of the relative toxicity, and of the nature of the substance which is responsible for the ferric chloride reaction. It is hoped that this preliminary report may soon be followed by a detailed publication in which these other points will be definitely cleared up.

Field Tests with Plant Foods, Materials and Results: H. A. HUSTON.

In the winter wheat section of the United States, commercial plant foods are very profitably used, while the reports of most of the plot tests at experiment stations indicate that they are unprofitable. Some reasons for this apparent conflict are pointed out, special reference being made to necessity of using materials free from substances like the gypsum contained in acid phosphate and the sodium in nitrate of soda capable of producing indirect effects, to the desirability of using suitable methods of application, proper amounts of materials, and reasonable interpretation of results.

The Negative Influence of Soils upon the Nitrogen Content of Wheat: G. W. SHAW.

In connection with another research the analytical results of which have been published in Bulletin No. 128 of the bureau of chemistry, department of agriculture, experiments have been conducted to differentiate between the climate and soil factor upon the protein content of wheat.

In 1907 until the present season the writer has undertaken to neutralize one of these factors, viz., climate, by securing from Hays, Kans., a plat of soil $6 \times 3 \times 3$ feet which for a long period had produced high protein wheat, and the preceding season produced wheat carrying 20.06 per cent. of total protein. A quantity of this wheat was also obtained at the same time.

The soil was removed from its original position in six-inch layers and brought to California, where it was placed alongside of a plat of California soil prepared in a similar manner, each of the holes having been first lined, except at the bottom, by a loose cement lining.

On one end of each of these plats was grown in 1907–8 wheat from the original high-protein wheat from Kansas, and on the other end a hand-selected low-protein durum wheat. By this soil transfer it was intended to neutralize the effect of climate and to have as a variable factor *only* the soil.

In physical character each of the soils would be classed as silt loams. Chemically there was essentially no difference in the top foot, which held particularly true in the essential elements of plant food. In the other two feet the main difference lay in the nitrogen content, this being the greater in the California soil, thus giving it a slight advantage in this respect. The detailed analyses are presented in tabular form.

In the first season the grain produced from the low-protein original increased by about 4.5 per cent. on each of the two plats, there being a difference of only 0.07 per cent. total protein

[1] U. S. Dept. Agri., Bureau Animal Industry Bull. No. 118.

between the soils under comparison, thus indicating a very marked seasonal influence toward the formation of high protein grain, and at the same time that the influence of the soil was practically nil.

In the case of the grain produced from the high-protein original from Kansas showing 20.06 per cent. total protein, there was a decrease on each of the soil plats by about 2 per cent., but as between the soils there was a difference of but 0.27 per cent. In each case the slight difference was in favor of the California soil, but the difference was altogether too small to be attributed with any certainty to inherent difference in soil composition.

In 1908–9 a similar condition was again shown on these plats, leading to like conclusions.

The alcohol-soluble nitrogen also points in this direction, for the difference in this component of the grain from the two plats is only 0.06 per cent., this being in favor of the California soil. In the matter of salt-soluble nitrogen we find such small differences as do occur are in favor of the Kansas soil.

Thus we have a soil which in Kansas has for many years produced a very high protein grain, when brought to California and placed under the same conditions as the home soil, producing grain of the same protein content as the native soil.

These experiments are being carried further to endeavor to ascertain which of several climatic factors may have the predominating influence.

The following papers were also presented:

The Relation of Carbon Dioxide Excretion to Body Weight: G. O. Higley.

The Carbon Dioxide Excretion as Modified by Barometric Changes: G. O. Higley.

The Physiological Action of Thallium Salts as shown by the Nitrogenous Metabolism: R. E. Swain.

The Utilization of Starch Introduced Directly into the Circulation: R. E. Swain.

The Destruction of Invertase Solutions in the Absence of a Preservative: F. C. Cook.

The Destruction of Invertase Solutions by Shaking and by the Electric Current: F. C. Cook.

Résumé of the Work of the California State Food and Drug Laboratory: M. E. Jaffa.

Testing for Saccharin: Louis H. Jackson.

Citral in Lemon Oils and Extracts: R. S. Hiltner.

The Composition of Rice as Affected by Fertilization: W. P. Kelley.

Division of Industrial Chemists and Chemical Engineers

A special feature of the program of this division was the symposium on smelter smoke, which was full of interest. Three important papers had been prepared for this occasion:

The Smoke Problem and the Community: Chas. Baskerville.

The Neutralization and Filtration of Smelter Smoke: W. C. Ebaugh.

The Electrical Precipitation of Suspended Matter: F. G. Cottrell.

The Smoke Problem and the Community: Charles Baskerville.

In this paper, which opened the symposium on "Smelter Fumes," the smoke problem is discussed historically, and from sociological, legal and economic view points. The methods which have been suggested for smoke abatement and the use of waste-reclaiming devices; the occurrence of sulphur dioxide in city air; the effects of sulphur dioxide and other waste gases; and the work of the expert in cases arising from the emission of noxious gases, are considered in their various phases; but the larger portion of the paper deals with the legal status of the smoke problem, and various recommendations with respect to legislation, jurisdiction and administration are made. From a study of the foreign legislation relating to noxious emissions, and the practicability of remedies in general, it is concluded that "the main solution of the 'fume question' and 'air pollution' would seem to be in the enforced use of waste-reclaiming devices, by the enactment of a federal law regulating the amounts of waste gases to be permitted to pass into the air."

The Effect of Varying Amounts of Litharge in the Fire Assay for Silver: Kenneth Williams.

In seeking to account for variable results obtained in the crucible assay for silver on oxidized lead ores, containing only traces of such impurities as copper, zinc and arsenic, a series of assays were run, using fluxes containing varying amounts of litharge in excess of the amount necessary to furnish a lead button of convenient size for cupellation.

It was found that with increased amounts of excess litharge, lower silver values were obtained.

The amount of variation was from one to four tenths of an ounce per ton on ores carrying from twenty-five to fifty ounces of silver.

Problems in Chemical Industry: John T. Baker, Phillipsburg, N. J.

In this paper the author pointed out that the

number and complexity of the factors involved in chemical operations are so great that many operations are still carried on under the rule of thumb guidance and have not been reduced to a science. On the other hand, the trained scientific man is very prone to believe that the matter with which he deals will follow the laws which he has learned, and for this reason he often overlooks valuable facts which the untrained observer sees. The untrained observer ignores laws and systems, tries any suggestion that comes along, and while much valuable time and labor may be lost, the loss is fully compensated by a few valuable successes. The investigator who is successful follows a mean between these paths. A number of practical illustrations of these principles were given.

Factors Affecting the Electrolytic Method for the Determination of Copper in Ores: W. C. BASDALE and W. H. CREUSS.

The paper discusses and gives the results of experimental data relating to the rate of precipitation of copper, as affected by the form of electrodes used, the amperage, the concentration of the solution and the kind and nature of the acid present. It is also shown that the presence of salts of ferric iron merely delays precipitation where no NO_3 ions are present, but where the latter are present and the amount of iron is large, complete precipitation is sometimes impossible. This is attributed to the formation of nitrous acid, which has a strong solvent action on metallic copper. The difficulty can be avoided by the addition of urea to the solution.

The Electrolytic Determination of Zinc in Ores: GEO. KEMMERER.

Recent workers obtained high results using an electrolyte containing a small excess of sodium hydroxide. These results were confirmed with similar electrolytes. With 20 to 25 grams of sodium hydroxide per 100 c.c. the results were not high and all the zinc was precipitated. A nickel gauze cathode and rotating anode were used with a current $N.D._{100}$ 3.1 amperes.

When applied to ores the sulphide obtained by the "modified Waring" method contained iron. This was eliminated by adding four to five drops of concentrated hydrochloric acid to the neutral solution where the Waring method calls for six drops of one-to-six acid.

This sulphide dissolved in hydrochloric acid, evaporated with 2 c.c. of sulphuric acid to dense fumes was dissolved in 100 c.c. of water, 25 grams of sodium hydroxide added and electrolyzed. The results varied less than 0.3 per cent. and agree well with the volumetric results on standard ores.

The titles of other papers presented are as follows:

Scum or Efflorescence on Brick: A. F. GREAVES-WALKER.

The Composition of Solids Precipitated from the Atmosphere during a "Salt Storm": W. C. EBAUGH.

The Scientific Use of Crude Petroleum as a Source of Power: LEON LABONDE.

The Cuban Hedge Cactus; a Proposed Source of Crude Rubber: CHAS. P. FOX.

Ficus elastica in Florida: CHAS. P. FOX.

Some Recent Advances in Textile Chemistry: J. M. MATTHEWS.

Alloys of Nickel and Cobalt with the Metals of the Chromium Group: ELWOOD HAYNES.

Rust as an Accelerator in the Corrosion of Iron and Steel: W. D. RICHARDSON.

Rapid Estimation of Available Calcium Oxide in Lime Used in Cyanide Work: L. W. BAHNEY.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

Stratification in Suspensions: F. K. CAMERON and E. E. FREE.

When a little very fine clay or similar material is added to water and allowed to settle, there are usually formed a number of strata differing in clay content and which are separated by more or less sharp surfaces. These surfaces move slowly downward with the settling of the material. Previous work on this phenomenon is largely worthless because of the disturbing effects of convection currents in the medium. The authors have constructed a double-walled cabinet inside which temperature changes are very slow and uniform and by the use of which these convection currents can be almost entirely avoided. Using this cabinet, the rates of fall of the strata of a number of clay-water mixtures have been carefully measured. The rate of fall of each stratum is constant, but a stratum may divide into two, one of which falls faster, the other more slowly, than the original. This division may be several times repeated. The number of strata formed in any particular system and their rates of fall seem to be determined partly by the nature of the system and partly by other, and apparently accidental, factors which are not yet understood.

The Consolidation of Kaolin Precipitates: F. K. CAMERON and E. E. FREE.

When mixtures of powdered kaolin with from

ten to one hundred times its weight of water are shaken and allowed to stand in tall jars or cylinders, there develops almost at once a sharp surface between the falling kaolin and the clear solution above. This surface sinks as the kaolin consolidates and its rate of fall represents the rate of consolidation of the kaolin. The curve representing the relation between the position of this surface (or the apparent volume of the kaolin) and the time of standing has been found to be an hyperbola, the central portion of which may be represented quite well by an exponential equation analogous in form to that of the mass law. On both ends of the curve the fall is slower than required by this equation. The reasons for these retardations are being more fully investigated.

The Action of Potassium Hydroxide upon Kaolin Suspensions: F. K. Cameron and E. E. Free.

The authors have studied the action of varied concentrations of potassium hydroxide on the degree of flocculation (and hence of the rate of settling) of suspensions of one gram of finely powdered kaolin in 100 c.c. of water. In very dilute solutions there is no noticeable action. At a concentration of about 0.015 gram KOH per liter of solution there begins suddenly a strong deflocculation or decrease in the degree of flocculation. At about 1 gram per liter the degree of flocculation begins to increase slowly and at about 4.5 grams per liter the degree of flocculation is the same as in pure water. This increase continues with increase in the KOH content and at about 10 grams per liter the degree of flocculation reaches a maximum after which it very slowly decreases. This final decrease is probably more apparent than real and due to the direct effect of the increased viscosity and density of the solution on the rate of settling.

Heats of Reaction in Non-aqueous Solvents (preliminary paper): J. Howard Mathews.

The first reaction chosen for study was the exact neutralization of 1 molecule of pyridine by 1 molecule of acetic acid. The product of this reaction is a liquid, and remains in solution in all of the solvents used. The heat evolved by this reaction in ten different solvents was measured by a slight modification of the adiabatic method devised by Richards and Rowe[2] for measuring specific heats of liquids. The quantity of heat evolved was found to depend on the solvent used. In solvents where side reactions were impossible the values obtained were of the same order as the value obtained where no solvent was used, but the differences were much greater than the experimental error, which was certainly less than 0.1 per cent. The study is to be continued.

[2] *Z. physik. Chem.*, 64, 187, 1908.

A Suggestion to Instructors in Quantitative Analysis: W. C. Ebaugh.

Material for use of students in quantitative analysis can frequently be obtained from commercial laboratories in the neighborhood of a technical school, and will save much time and trouble as well as expense to teachers. The portions of samples that have been analyzed, or reserve samples that have been prepared for the use of an umpire, but not needed for that purpose, are issued to students, and as the analysis results used for settlement are furnished by the laboratories that prepared the samples the work of the students can be checked accurately. It has been found that students take a greater interest in analyzing such samples than in working with material that has not been in commercial use.

A Reported Occurrence of Native Iron: W. C. Ebaugh.

A sample of metal, thought to be platinum, was sent to the University of Utah by Cecelia M. Gettings, of Moab, Utah. Later a second sample from the same source was received, and an affidavit accompanied it declaring that the material had been found in a certain mining (placer) claim in the La Sal Mountains east of Moab. The material proved to be magnetic, was malleable, had a specific gravity of 7.82, and upon analysis yielded

Carbon	0.08 per cent.
Silicon	0.20 per cent.
Phosphorus	0.0003 per cent.
Sulphur	undetermined
Manganese	traces
Nickel	absent
Cobalt	absent
Aluminum	absent
Chromium	absent

There seemed to be no question in the minds of the men who discovered the metal that it was of native occurrence, and could not have come into the deposit from tools or other articles made by man.

Equilibrium in the System KI, I and Aqueous Alcohol: C. L. Parsons and H. P. Corliss.

Equilibrium experiments carried out in detail show positively that no solid polyiodides of potassium exist at 25°. The solubility curves were

traced throughout their full length and the invariant point found when both potassium iodide and iodine existed together as solid phases in presence of their mutually saturated solutions. The curve was traced for both 60 and 40 per cent. alcohol.

The Solubility of Barium Nitrate in Solutions of Barium Hydroxide: C. L. PARSONS and H. P. CORSON.

The solubility curves were traced for barium nitrate in all concentrations of barium hydroxide and likewise for barium hydroxide in all concentrations of barium nitrate. The solubility of each was shown to be *increased* by the presence of the other. It was also shown that no solid basic nitrate of barium can exist at 25°.

The Solubility of Strontium Nitrate in Solutions of Strontium Hydroxide: C. L. PARSONS and C. L. PERKINS.

Strontium nitrate and hydroxide were found to be strictly analogous to barium as described in preceding abstract.

Basic Nitrates of Yttrium: CHAS. JAMES and L. A. PRATT.

Equilibrium experiments show that only one basic nitrate of yttrium exists, viz., $3Y_2O_3 \cdot 4N_2O_5 \cdot 20H_2O$. The solubility curves are also shown.

Comparative Analyses of Water from Great Salt Lake: W. C. EBAUGH and WALLACE MACFARLANE.

From 1900 until 1904 fears were expressed that the Great Salt Lake was doomed to extinction, as a continuous recession of the shore line took place. Since that time there has been a rise in the level of the lake and during the year just ended new fears have arisen—fears that large engineering works like the Lucin cut off of the Southern Pacific and the roadbed of the Western Pacific Railroad would have to be abandoned. A succession of years with abnormally high rainfall is responsible for the condition now existing.

Analyses of the water since 1850 are collated and many new analyses given. These show the density to have been as low as 1.102 in 1873 and as high as 1.2206 in 1903; total solids varying from 13.42 per cent. to 27.72 per cent. The figures for February, 1910, being specific gravity 1.1331 and total solids 17.681 per cent. Complete analyses of the water for the years 1903, 1904, 1907, 1909 and 1910 are also reported.

Improvements in Molecular Weight Determinations by the Boiling Point Method: L. P. SHIPLEY and J. O. ZIEBOLTZ.

The thermometer is placed above the liquid and the boiling of the latter is made to pump a portion of it over the bulb in a thin film analogous to the reflux current in the ordinary arrangement for determining boiling points of pure liquids. Errors from superheating are thus practically eliminated and steadiness of thermometer readings increased at least tenfold besides simplifying the apparatus now in general use.

Interrelations of the Carbide and Nitride of Magnesium: F. G. COTTRELL.

A mixture of anhydrous liquid ammonia and acetylene at room temperature attacks metallic magnesium rapidly, forming clear colorless tetrahedra of $MgC_2 \cdot C_2H_2 \cdot 5NH_3$, which lose one and a half molecules of ammonia sharply at 2° C. and atmospheric pressure. Above 60° C. they give off a mixture of acetylene and ammonia, leaving a little carbide and much nitride of magnesium. At low temperature in vacuo, on the other hand, the essentially pure carbide, previously unknown, may be obtained. The carbide, a white powder, begins to decompose into its elements at 425 to 450° C. Metallic magnesium dissolves slightly in liquid ammonia with faint blue color, and even at room temperature slowly forms the amide and hydrogen.

Apparatus for Determining Vapor Pressures of Slightly Volatile Solids: H. V. WELCH.

The method depends upon determining the amount of material carried off in a known volume of air or other gas passed through a tube of the solid in a thermostat. The latter is of the boiling liquid type, temperature regulation being effected through automatic electrical control of a valve leading to a vacuum pump. Arsenic trioxide and similar solids are being investigated at present.

Preparation of Pure Anhydrous Ethyl Alcohol: E. C. MCKELVY.

The demand for alcoholometric density tables of greater precision than the various discordant ones in use at present has led to the repetition at the bureau of standards of the experimental work upon which such tables are based. Absolute alcohol was prepared by using several different dehydrating agents including lime, calcium and aluminium amalgam. The density results obtained were very concordant and point to a value for the density of 0.78506 ± 0.00001 at 25°/4° which is slightly lower than Mendeleef's corrected value. Acetaldehyde was found to increase the density while ethyl ether and dissolved air had the opposite effect.

The Rapid Determination of Silver, Copper, Cadmium and Bismuth by Means of the Mercury Cathode and Stationary Anode: R. C. Benner.

Work which has been recently completed indicates that the rapid electrolytic determination of many metals can be accomplished by means of stationary electrodes in nearly the same time as with the more complex forms of apparatus.

In order to avoid loss by boiling of the solution when high currents are used, tall electrodes similar to those utilized by Smith were constructed. Standard solutions of copper nitrate, silver nitrate, cadmium sulphate and bismuth nitrate were prepared from chemically pure materials. The electrolysis was carried out in case of each metal in the presence of nitric acid, and sulphuric acid, with a current varying from three to four amperes. The solution always had a volume of twenty cubic centimeters. The results were as accurate as could be desired and as good as those obtained by Smith by means of the rotating anode and mercury cathode. It is possible to precipitate 0.3833 gram of copper in twenty minutes, 0.2856 gram of silver in ten minutes, 0.743 gram of cadmium in ten minutes and 0.4650 gram of bismuth in twenty-five minutes.

The Atomic Weight of Tantalum: Clarence W. Balke.

Tantalum oxide was prepared from purified potassium fluotantalate. It was converted into tantalum pentachloride. The latter, weighed in quartz bulbs with great care to avoid contact with moist air, was hydrolyzed in portions weighing from six to eighteen grams and the weight of tantalum oxide determined. Eight determinations gave values for the atomic weight of tantalum from 181.46 to 181.55 with a mean of 181.52, which is one half of a unit higher than the value given in the International Table of Atomic Weights.

Apparatus for the Determination of Arsenic: Otis D. Swett.

This is a self-contained apparatus, disposed vertically within the limits of its base, which has a diameter of 11 cm., and having a height of 44 cm. The reaction chamber is surrounded by a jacket through which hot or cold water may be passed as a temperature control. The charge is admitted through a tube, sealed into a stopper ground into the neck of the reaction chamber, and extending to near the bottom of the latter, where it terminates in a gas trap bend. The arsine enters a tube, sealed into the said stopper, passes through a drying tube, and into a combustion tube, fitted by means of a flat connection with spring clip to the exit from the drying tube, and heated electrically. Arsenic mirrors are formed and compared with standards. The combustion tube may be replaced by a suitably bent tube with a horizontal limb carrying a sensitized paper.

Potassium Ammonoplumbite and Potassium Ammonocadmiate: Edward C. Franklin and George S. Bohart.

Franklin and his coworkers have shown that liquid ammonia is an electrolytic solvent which exhibits many striking similarities to the more familiar solvent water. In particular they have shown that just as the ordinary oxygen or "hydro" acids, bases and salts may be said to constitute a water system, so there exists a large number of nitrogen compounds which similarly constitute an ammonia system of acids, bases and salts.

The authors now show that just as potassium hydroxide, a water or hydrobase, in aqueous solution, reacts with lead hydroxide, an amphoteric hydroxide, to form the hydrosalt, potassium plumbite, in accordance with the equation,

$$2KOH + Pb(OH)_2 = Pb(OK)_2 + H_2O,$$

so potassium amide, an ammonobase, in solution in liquid ammonia, acts upon lead imide, an amphoteric imide, to form the ammonosalt, potassium ammonoplumbite in accordance with the equation,

$$KNH_2 + PbNH = PbNK + NH_3.$$

The salt separates from concentrated solutions in the form of beautiful, colorless, transparent crystals of the formula, $PbNK \cdot 3NH_3$.

A potassium ammonocadmiate of the formula, $Cd(NHK)_2 \cdot 2NH_3$, has been prepared by the action of an excess of a solution of potassium amide on cadmium iodide suspended in liquid ammonia.

Cuprous Nitrate: Wm. H. Sloan.

When metallic copper is digested with a solution of cupric nitrate in liquid ammonia and cuprous nitrate is formed and may be isolated in the form of colorless crystals by the evaporation of the solvent. The composition of the crystalline salt is represented by the formula, $CuNO_3 \cdot 4NH_3$.

The Viscosity of Ammonia, Methylamine and Sulphur Dioxide and Certain of their Solutions: F. F. Fitzgerald.

In agreement with the hypothesis that the more fluid electrolytic solvents give solutions which exhibit high maximum molecular conductivities

the author has found these solvents to possess a high degree of fluidity.

The Electrical Conductivity of Solutions in Methylamine and Ethylamine: F. F. FITZGERALD.

The author has measured the conductivity of a number of salts in these solvents through a considerable range of concentrations and at temperatures ranging from + 15° to — 33°. The maximum and minimum of the molecular conductivity curve, first noted by Franklin and Gibbs, have been found to characterize all the solutions studied.

The Charges of Ions in Electrolysis: FERNANDO SANFORD.

Since no case is known where an electrolytic ion gives off a positive charge to an electrode, we have no way of measuring directly the positive charge on such an ion. If the ions are assumed to have very short free paths, they will move with accelerated velocities. If this acceleration were uniform, their relative ionic charges could be computed from the equation force = mass × acceleration, since in a given electric field the force acting upon an ion is proportional to its charge.

The following table shows the relative charges of three groups of ions calculated in this way:

Element	Atomic Weight	Ionic Velocity	Ionic Charge	Ratio of Charges
Cs	133	78.8	10480	Cs/I = 1.07
Rb	85.5	78.6	6720	Rb/Br = 1.07
K	39	75.5	2945	K/Cl = 1.09
Na	23	52.6	1210	Na/F = 1.17
Li	7	42.6	298	
H	1	365	365	
I	127	77	9779	I/Ba = 1.04
Br	80	78.1	6248	Br/Sr — 1.06
Cl	35.5	75.1	2666	Cl/Ca = 1.07
F	19	54.4	1034	F/Mg = 1.02
Ba	137.4	68	9343	Cs/Ba = 1.12
Sr	87.6	67	5869	Rb/Sr = 1.14
Ca	40.1	66	2646	K/Ca = 1.11
Mg	24.3	46	1018	Na/Mg = 1.18

Titles of other papers of which no abstracts have been received follow:

Further Studies on the Action of Ammonia upon Ethyl-phospho-platino-chloride: CHAS. H. HERTY and HAMDEN HILL.

The Temperatures of the Carborundum Furnaces: WILDER D. BANCROFT.

Salvaging Sulphated Storage Cells: WILDER D. BANCROFT.

The Silver Coulometer: G. D. BUCKNER and G. A. HULETT.

Occlusions in Electrolytic Silver: J. S. LAIRD and G. A. HULETT.

An Exact Electrolytic Method for Determining some Metals: W. L. PERDUE and G. A. HULETT.

Cadmium Sulphate and the Atomic Weight of Cadmium: W. L. PERDUE and G. A. HULETT.

A Common Thermometric Error in Determining Boiling Points under Reduced Pressure: ALEXANDER SMITH.

A Convenient Form of Vapor Density Apparatus: ALAN W. C. MENZIES.

The Systems, Lime-water-sugar and Lime-water-glycerine at 25° C.: F. K. CAMERON and H. E. PATTEN.

Phosphates of Lime IV.: F. K. CAMERON and J. M. BELL.

The Influence of Organic Liquids upon the Interaction of Hydrogen Sulphide and Sulphur Dioxide: DAVID KLEIN.

Concerning the Molecular Weight of Sulphur Vapor: O. F. STAFFORD.

A Rotating Graphite Anode: J. W. TURRENTINE.

Behavior of Certain Hydrazine Salts in Liquid Ammonia: A. W. BROWNE and A. E. HOULEHAN.

Electrolysis of Solutions of Potassium Amide and of Ammonium Trinitride in Liquid Ammonia: A. W. BROWNE and M. E. HOLMES.

Electrolytic Corrosion of Various Metallic Anodes in a Solution of Ammonium Trinitride in Liquid Ammonia: A. W. BROWNE, M. E. HOLMES and J. S. KING, JR.

The Examination of Ethyl Ether: CHARLES BASKERVILLE and W. A. HAMOR. (*a*) A Study of the Tests for Odor, Residue, Acidity and Sulphur Compounds in Ethyl Ether. (*b*) The Tests for the Presence of Water and Alcohol in Ethyl Ether. (*c*) On the Changes Occurring in Stored Ether and on the Existence of Ethenol in Ethyl Ether. (*d*) The Tests for the Presence of Peroxides and Acetaldehyde in Ethyl Ether. (*e*) On some New Tests for the Detection of Peroxides in Ethyl Ether. (*f*) The Examination of Ethyl Ether intended for Anesthetic and Reagent Purposes; the Degrees of Purity of American Ethers, and Recommendations for the Standardization of Anesthetic Ether.

Mechanical Stimulus to Crystallization: S. W. Young.

Zinc Ammonium Sulphate: Eloise Jameson.

Conductivity of some Solutions in Ammonia-water Mixtures: Wm. H. Sloan.

DIVISION OF ORGANIC CHEMISTRY

Stilbazoles in the Quinazoline Group: M. T. Bogert and G. D. Beal.

2-methyl-4-quinazolones and 3-amino-4-quinazolones both condense with aromatic aldehydes, the condensation taking place with either the methyl or the amino group, or both. The products obtained by the condensation with the methyl group are of stilbazole type, those with the amino group are somewhat analogous to the Schiff bases. The aldehydes used were benzaldehyde, salicylaldehyde, vanillin and cinnamic aldehyde. Very strangely, no good condensations were obtained with citral or with furfural. The aldehydes condense first with the amino group and then with the methyl group. When the products are treated with strong hydrochloric acid the aldehyde group is easily broken away from the nitrogen but not from the carbon union. Various derivatives were prepared and studied.

Isocampholactone: W. A. Noyes and A. W. Homberger.

When isocampholactone is treated on the water-bath with nitric acid (1.27) a nitroisocampholactone, $C_9H_{13}O_4N$, is formed. This gives an amine and a hydroxylamino compound by reduction with tin and hydrochloric acid or zinc and acetic acid, respectively. The nitrolactone gives an amide, $C_9H_{16}N_2O_3$, on treatment with ammonia and an acid, $C_9H_9NO_4$, on treatment with sodium hydroxide. At the same time with the nitroisocampholactone a small amount of a lactone acid, $C_9H_{14}O_4$, was also formed. From this an amide, $C_9H_{15}NO_4$, was prepared.

Separation of αα'-dimethyladipic Acid into its Optical Isomers and Synthesis of Laurolene: W. A. Noyes and L. P. Kyriakides.

Although there seems to be no reason, theoretically, why dialkylsuccinic acids and other acids of a similar type should not be capable of separation into their optical isomers, all attempts to effect such a separation have, heretofore, been unsuccessful. Lean and some others have gone so far as to suppose that there must be some reason, inherent in the nature of these compounds, why such a separation is impossible. By means of the acid brucine salt we have obtained without serious difficulty both the dextro and levo forms from the racemic αα'-dimethyladipic acid (m.p. 72°). Dimethyl-cyclopentanone prepared from the active acid proved to be inactive. From the ketone trimethyl-cyclopentanol was prepared by the Barbier-Griguard reaction. This loses water on distillation, or more completely on warming with anhydrous oxalic acid, giving laurolene, thus confirming Eÿkmann's formula for the latter and also the results previously obtained by Noyes and Derick from its oxidation.

Derivatives of Isocamphoric Acid: W. A. Noyes and Luther Knight.

Aschan's method of preparing isocamphoric acid has been improved by using a much larger proportion of camphoric acid and decreasing the amount of hydrochloric acid in the sealed tubes. From isocamphoric acid the acid methyl esters and from this β-isocamphoramidic were prepared. The last gave, by Hofmann's reaction, an amino acid which is called, provisionally, dihydroamino-iso-α-campholytic acid. This gives with nitrous acid, not the dihydrohydroxyisocampholytic acid which was expected, but *l*-dihydrohydroxycampholytic acid identical with the same acid prepared by a different method some years ago. An unsaturated acid, probably the *d*-α-campholytic acid which was to be expected, and a lactone were also formed.

Decomposition of Nitrosophthalimidine in the Presence of Alcohol: W. A. Noyes and James A. Coss.

Some years ago Noyes and Taveaur discovered that when the nitroso derivative of the anhydride of aminolauronic acid is decomposed in the presence of alcohol and sodium hydroxide a compound

$$\left(C_8H_{14}\begin{matrix}CO\\ \downarrow\\ N(C_2H_4O)\end{matrix}\right)_2,$$

is formed, if similar compound is obtained in small amount from nitrosophthalimidine, but the principal product is an oil which is free from nitrogen. This oil gives phthalic acid by oxidation and orthotoluic acid and ethyl iodide on heating with hydriodic acid, but its nature has not yet been fully established.

Conversion of Quinine into Quinotoxine: H. C. Biddle and T. B. Kelly.

As a possible explanation of the occasional toxicity of the cinchona alkaloids, it is found that the formation of quinotoxine from quinine (so cinchotoxine from cinchonine) is determined largely by the action of certain organic acids as catalytic agents. In the presence of mineral acids

at 100°, quinine shows no conversion to quinotoxine; while in the presence of many organic acids, partial conversion is effected in a few hours at temperatures as low as 30–35°, and appreciable conversion is shown on longer standing even at room temperature (18°). It consequently appears that under suitable conditions quinine may give rise to quinotoxine in the human system.

The reaction is of additional interest as presenting a case of catalysis by acids in which the change is apparently not affected by the hydrogen ion of the acid present.

Other papers presented for which no abstracts have been received:

The Unsaturated Character of the Resin of Pinus sabiniana: CHAS. H. HERTY and E. N. TILLETT.

A Study of the Resene of Pinus heterophylla: CHAS. H. HERTY, W. A. HOUCK and T. P. NASH.

Action of Acetic Anhydride on p. Methoxy-phenyl-propiolic Acid and on Methylene Ether of 3-4 Dihoxy-phenyl-propiolic Acid: MAURICE L. DOLT.

The Constitution of the Oxonium Salts: M. GOMBERG.

Action of Amines on Phthalic Acid VII. Phthalamidic Acids containing Cl or NO_2 in the Benzene Nucleus: J. BISHOP TINGLE and S. J. BATES.

Camphoroxalic Acid XIII. Action of Amines on Camphoroxalic Acid: J. BISHOP TINGLE and S. J. BATES.

DIVISION OF PHARMACEUTICAL CHEMISTRY

Asafetida: W. A. PEARSON.

Considerable analytical data are presented to illustrate the extent of variation due to sampling, methods of assay and loss in powdering. Improper sampling may be responsible for an error of 100 per cent., methods of assay about 2 per cent., while during drying preparatory to powdering a loss of approximately 20 per cent. is incurred.

Capsaicin, the Pungent Principle of Capsicum and the Detection of Capsicum: E. K. NELSON.

Capsaicin was isolated from capsicum by the method of Micko, and its properties studied.

From fifteen hundred grams of selected African pods, 2.13 grams of pure, crystalline capsaicin were obtained, representing 0.14 per cent. of the original material.

The extreme pungency of capsaicin was found to be the only property of the body of service in detecting small quantities of capsicum, and a method is proposed by the author for the detection of capsicum when used to fortify ginger preparations.

Note on the Volatility of Cocain: H. C. FULLER.

When drying cocain residues during the process of analyzing galenical preparations, it was noted that at 100° C. the cocain alkaloid was volatile, collecting as a sublimate on the sides of the dish and on the watch glass used as a covering. Experiments showed that there was no loss at 60, 80 and 90 degrees, but at 98 degrees the cocain began to sublime and figures are given showing the gradual loss at 100° C.

Separation and Determination of Cocain and Strychnin, and Atropin and Strychnin when they occur Together: H. C. FULLER.

The alkaloids are extracted from the drug product and weighed together, using proper precautions to obtain them in a pure condition. They are then dissolved in alcoholic potash, transferred to a pressure flask and heated over the steam bath for one hour, which completely hydrolyzes the cocain and atropin, but does not affect the strychnin. The latter is then separated and weighed.

The Correlation of the Microscopical and Chemical Analyses of Vegetable Drugs, Foods and Spices: ALBERT SCHNEIDER.

Calls attention to the value of the compound microscope as a ready means for determining the quality and purity of foods and drugs. The relative value and significance of the chemical and microscopical analyses is outlined. The microscopical method is of first importance in the examination of vegetable substances of all kinds and the solid preparations made therefrom while the chemical method is of first importance in the analysis of liquids, solutions and chemicals generally. The microscopical method is quick in results, the chemical method often slow and tedious. Most analyses are incomplete without both methods. The work for the chemical analysts and the micro-analysts is outlined. The bacteriological testing of substances that require it is assigned to the micro-analyst rather than to the chemist.

Titles of other papers follow for which no abstracts have been received:

Determination of Iodine and Chlorine in Thymol Iodide by Electrolytic Means: B. L. MURRAY.

Electrolytic Determination of Mercury in the Mercury Salts of the Pharmacopœia: B. L. MURRAY.

Ash Determinations and Ash Contents of Vegetable Drugs: Edward Kremers and W. H. Kendall.

The Physiological Assay of the Heart Tonics of the Digitalis Series: E. M. Houghton.

Charles L. Parsons,
Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The seventeenth summer meeting of the society was held at Columbia University on Tuesday and Wednesday, September 6–7, 1910, extending through two sessions on each day. Thirty-six members were in attendance. Vice-president Hutchinson occupied the chair. The council announced the election of the following persons to membership in the society: Mr. F. S. Bartlett, General Electric Company, Schenectady, N. Y.; Mr. R. D. Beetle, Dartmouth College; Professor N. C. Grimes, University of Arizona; Professor F. T. H'Doubler, Miami University; Mr. Robert Henderson, Equitable Life Assurance Society, New York, N. Y.; Mr. G. F. McEwen, Stanford University; Professor Josephine A. Robinson, Berea College. Ten applications for membership in the society were received.

On Tuesday evening twenty-five of the members gathered at the usual informal dinner, always a pleasant feature of the meetings.

The following papers were read at the summer meeting:

L. E. Dickson: "On the factorization of integral functions with p-adic coefficients."

L. E. Dickson: "Determination of the binary modular groups and their invariants."

O. E. Glenn: "On the structure of p-ary forms."

R. D. Carmichael: "Linear difference equations and their analytic solutions."

H. T. Burgess: "The simultaneous reduction of a quadratic and a bilinear form by the same transformation on both x's and y's."

A. B. Coble: "On the reduction of the sextic equation to the Valentiner form problem."

Virgil Snyder: "The involutorial transformation of the plane, of order 17."

L. E. Dickson: "An invariantive investigation of irreducible binary forms."

Arthur Ranum: "On the classification of systems of linear equations."

Arthur Ranum: "The osculating sphere of a developable surface."

Peter Field: "The theory of degenerate rational plane curves."

J. E. Rowe: "Important covariant curves and a complete system of invariants of the rational quartic curve."

G. D. Birkhoff: "General theory of linear difference equations."

L. E. Dickson: "A fundamental system of invariants of the general modular linear group on m variables."

S. E. Slocum: "A general formula for the shearing deflection of beams of arbitrary cross section, either variable or constant."

G. A. Miller: "Note on the solution of a system of linear equations."

G. A. Miller: "Some relations between substitution group properties and abstract groups."

Jacob Westlund: "On the relative discriminant of a certain Kummer field."

J. W. Bradshaw: "On a method of deriving infinite products from certain infinite series."

Anna J. Pell: "Infinite systems of linear equations with unsymmetric systems of coefficients."

Edward Kasner: "Conformal invariants of curvilinear angles."

Florian Cajori: "Fourier's improvement of the Newton-Raphson method of approximation anticipated by Mourraille."

Louis Ingold: "Note on identities connecting certain integrals."

E. O. Lovett: "Generalizations of certain theorems concerning cases of collisions in the general problem of several bodies."

John Eiesland: "On minimal lines and surfaces in four-dimensional space."

John Eiesland: "Lie's line-sphere geometry from the standpoint of four-dimensional space."

E. D. Roe, Jr.: "A generalized definition of limit."

E. D. Roe, Jr.: "A new invariant function."

H. H. Mitchell: "The subgroups of the hyperorthogonal group $HO(3, p^{2k})$."

H. Beck: "Ein Seitenstück zur Moebius'schen Geometrie der Kreisverwandtschaften."

Abstracts of the papers will appear in the November number of the *Bulletin*.

The San Francisco section of the society met at the University of California on Saturday, September 24. The next regular meeting of the society occurs on October 29. The winter meeting of the Chicago section will be held at Minneapolis with the American Association.

F. N. Cole,
Secretary